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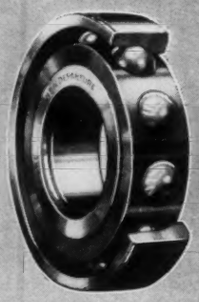

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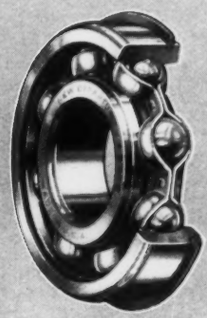

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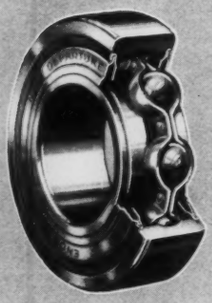

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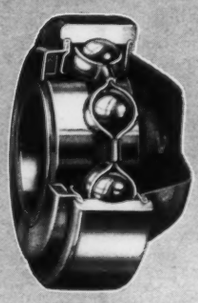

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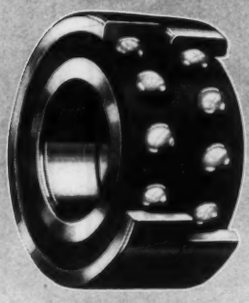

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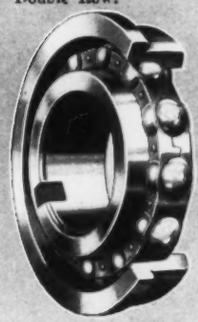

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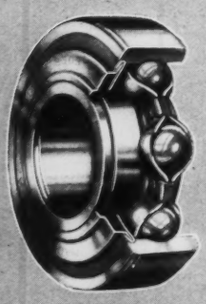

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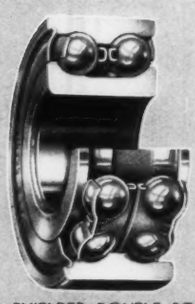
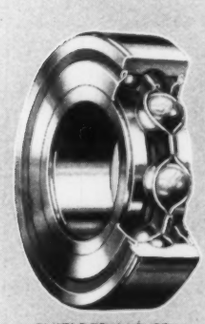


SHIELDED DOUBLE ROW

Double Row bearings with plate shield permanently attached to one side of outer ring, forming closure against dirt or foreign matter.



SHIELDED N-D-SEAL

N-D-Seal bearing with steel shield on side opposite seal. Shield keeps out dirt and protects bearing during mounting.

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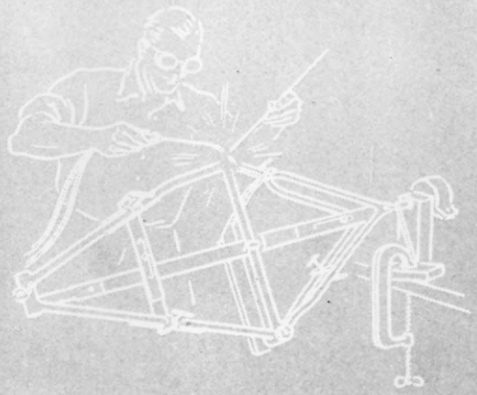


MACHINE DESIGN

What's Ahead in Metals?

By Oscar E. Harder
Assistant Director,
Battelle Memorial Institute

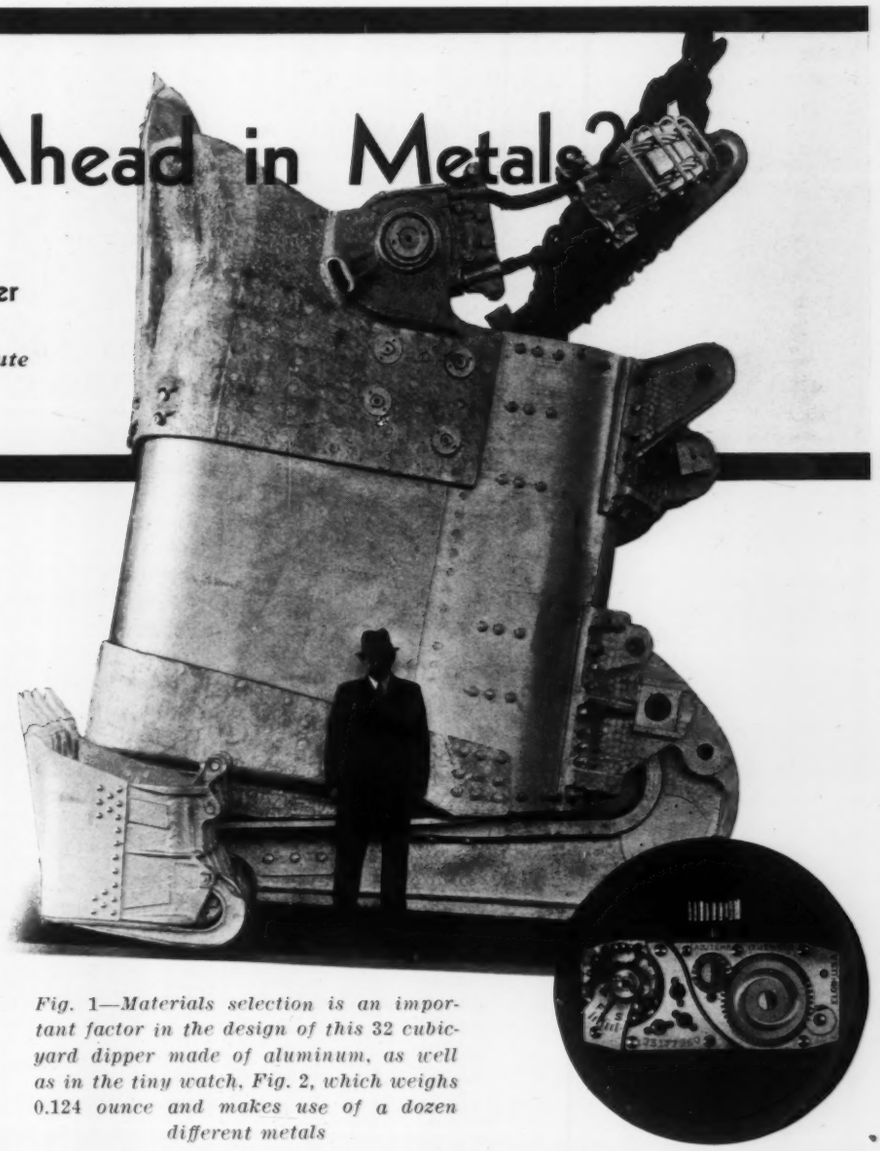


Fig. 1—Materials selection is an important factor in the design of this 32 cubic-yard dipper made of aluminum, as well as in the tiny watch, Fig. 2, which weighs 0.124 ounce and makes use of a dozen different metals

IN ATTEMPTING to look into the future with reference to new developments and trends in metals, we may consider the recent past, the present, and then make some deductions as to the future.

During the past few years metal producers have sought as never before to make materials to meet special requirements. Thus, we may be said to be getting into the "tailor-made" metals period. Keen competition among producers has undoubtedly had an important part in this trend, but there are other factors. For example, by research work the producers are in better position to supply materials to meet special requirements, but this condition is the direct result of the metal users knowing what they want and insisting that the suit should be made to order and be a good fit. These trends have been observed in machines ranging from the small ladies' watch movement, *Fig.* 2, weighing less than 0.008 pound, (including dial and hands and containing some 138 parts made of a dozen different metals, with jewels of sapphire, ruby, and garnet), to a giant shovel weighing over three million pounds, *Fig.* 1.

Aviation, where the ultimate reduction in

weight consistent with safety is demanded, has led the way in studying materials and methods of construction. Other transportation fields are following the trend. Moving parts and materials handling parts are also being studied.

Low-Alloy High-Strength Steels

Recent developments in low-alloy high-strength steels illustrate the work which the steel industry is doing to supply an industrial need. Some of these steels have been discussed in MACHINE DESIGN* and their advantages pointed out [2,3]. At the present time more than 20 steels falling into this general class have been developed and are on the market. Combinations other than those mentioned in the above reference include copper-nickel, copper-nickel-phosphorus, silicon-manganese - copper, and copper-silicon-phosphorus-chromium. Copper is being extensively used in these steels.

Low-alloy steels represent an interesting trend in which improved properties are obtained by relatively minor alloy additions; each element is added for a specific purpose. These steels make possible savings of one-fourth to one-third in weight, and in transportation machinery materially increase the pay load. This is suggestive of the future trend in metallurgy, in which the metallurgist familiar with

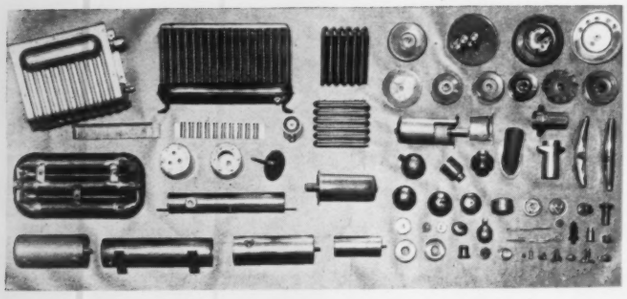


Fig. 3—Many miscellaneous parts such as these can be assembled economically by copper brazing

the effect of these various elements will build steels and other alloys for special purposes by using even more complicated analyses than we have at present, but in the end getting the desired product.

Importance of Small Alloy Additions

The potency of certain small alloy additions is being more clearly understood and more extensively used. Effect of a small amount of sodium on the microstructure, properties, and casting characteristics of aluminum-silicon alloys has been known for more than a decade; the effects of small additions of titanium or columbium to 18-8 stainless steel to prevent carbide precipitation in the grain boundaries during heating in certain temperature ranges, with the resulting embrittlement and susceptibility to intergranular corrosion and "weld decay," is of more recent origin; and still more recent is the announcement that the addition of such amounts of calcium or zirconium as 0.03 and 0.25 per cent respectively to nickel-chromium and nickel-chromium-iron electric resistor heating elements increases their useful life 400 to 600 per cent. On the other hand, the elimination of small amounts of impurities in the zinc used in zinc-base die castings licked the problem of disintegration of these alloys in many cases and greatly improved their stability. In the future more will be known about the effects of the minor constituents and where they should be used or avoided.

Mining Equipment

Especially during 1935 have important changes been made in the design of dippers for stripping equipment. For example, by use of a welded construction and redesigning, dipper capacities have been increased from 18 to 22 cubic yards and from 12 to 18 cubic yards. Another important element in increasing the capacity of dippers has been the use of strong aluminum alloys for much of the dipper. High-strength steels have decreased the weight or increased the strength of booms, and a combination of high-strength steel in the lower part of the boom with strong aluminum alloys for the remainder has made possible greater lengths or lighter weights or greater capacity for pay load in the dipper.

Apparently, the "big dipper" at present is the one of 32 cubic yards capacity built by Marion Steam Shovel Co., *Fig.* 1, in which a high-strength aluminum alloy was extensively used, increasing the capacity of the dipper about 33-1/3 per cent without overloading the shovel. The success which has been attained by redesigning with high-strength steels, with welded construction, and by the use of high-strength aluminum alloys in booms and in dippers suggests that the trend will be along these lines.

Alloys For High-Temperature Service

This discussion may be applied to three fields: Alloys subjected to high temperatures and pressures, such as in the petroleum-refining industry; alloys for furnace parts, such as heat-treating, normalizing, and radiant tube furnaces; and electric resistor alloys.

In the petroleum industry the carbon steels are limited to service at perhaps 700 to 800 degrees Fahr., in most cases, and they are also limited with reference to their resistance to corrosion. For somewhat increased temper-

*References at end of paper.

atures, probably up to 1000 to 1200 degrees, the 5 per cent chromium steels with ½ per cent molybdenum have been extensively used. These steels also possess somewhat improved resistance to corrosion and scaling. For the more severe service conditions, particularly with reference to corrosion, such steels as the 18 per cent chromium—8 per cent nickel, or cast steels containing still higher chromium and nickel, have been used. There still remains apparently a demand for a steel of lower cost than the 5 per cent chromium-½ per cent molybdenum steel which will have better properties than the plain carbon steels. Likewise, there appears to be a place, as Newell[12] has recently pointed out, for a steel intermediate between the chromium-molybdenum and the 18-8 steels, and he has proposed analyses containing 8 to 10 per cent chromium with 1.25 to 1.75 per cent molybdenum.

Centrifugal Casting Extends Applications

In alloys for furnace parts, certain compositions have been receiving preference by the manufacturers, and the quality of these alloys is being improved by more careful manufacturing methods. There is a lack of engineering data with reference to the high-temperature properties of these alloys, such as modulus of elasticity, creep characteristics, structural stability, and corrosion and scaling resistance. The adaptation of centrifugal casting to the production of these heat-resisting alloys, as recently described by Wilcox[18], would seem to extend their application, possibly resulting in some economy of production.

Mention has been made of the effect of additions of small amounts of calcium or zirconium or calcium and zirconium to improve the life of heat-resisting alloys of nickel-chromium and nickel-chromium-iron. There still remained a need for alloys to operate at higher temperatures, and two new developments in this direction are represented by the Kanthal alloys developed in Sweden containing about 21 per cent chromium, 5.5 per cent aluminum, 3.5 per cent cobalt, and the balance iron, and the A. O. Smith No. 10 alloy containing about 37.5 per cent chromium and 7.5 per cent aluminum developed in this country[13, 14]. These alloys make it possible to design furnaces to operate at temperatures considerably above the range of nickel-chromium resistors. While these alloys have some objectionable characteristics which can probably be remedied in the future, their development seems to mark a distinct advance in the use of metallic resistors for higher temperatures without the use of special reducing atmospheres required with tungsten and molybdenum heating elements and without the excessive cost of such elements as platinum.

The outstanding developments with reference to joining metals fall in the fields of welding and brazing. Extensive and advantageous applications which can be made in welding have been pointed out by Gibson[8] and have been referred to in a number of earlier issues of MACHINE DESIGN. Perhaps one of the most important developments in welding has been in the aircraft field, where chrome-molybdenum steels containing about 1 per cent chromium, 0.25 per cent molybdenum, and 0.30 per cent carbon have been so extensively used. This development has been discussed by de Ganahl[5].

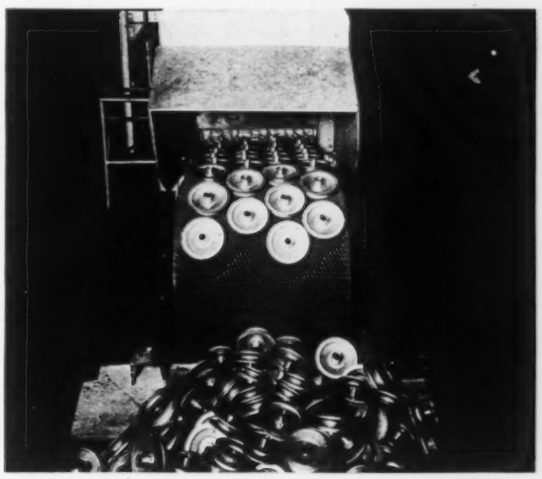


Fig. 4 — Continuous furnace discharging three-piece pulleys assembled by copper brazing

As applied to the building of parts of 18-8 stainless steel, an outstanding development has been the shot-welding process[15]. Thin sheet construction can be made by this process without introducing the problem of weld decay—that is, the tendency of the stainless steels to become embrittled and to lose their resistance to corrosion adjacent to the welds.

As mentioned in another place in this article, the introduction of titanium or columbium, particularly the latter, in 18-8 steel has been very helpful in overcoming intergranular precipitation of carbides, but as de Ganahl has pointed out there is yet needed the complete development of a fusion method which can be applied to stainless steel or a development of stainless steel and welding rod which can be used for making joints by fusion welding.

The other recent development of an improved method of joining metals is by copper brazing. *Fig.* 4 shows the discharge end of a copper brazing furnace which is being used to produce a three-piece pulley assembled by this method. The work comes out of the furnace securely joined, clean, and bright. *Fig.* 3 shows a number of parts assembled by copper brazing. Those familiar with this industry feel that its applications are almost unlimited and that it will come into more extensive use as mechanical designers

in general become more familiar with its advantages and possibilities.

For lower temperature brazing, special alloys have been developed, but some of these are rather expensive because of their silver content. There apparently is room for further development of an alloy which can be satisfactorily used at lower temperature than that required for copper brazing and an alloy which is less expensive than those containing silver which are now on the market. It is frequently desirable to assemble brass and bronze parts by brazing, and in these cases a solder of lower melting point than copper and less expensive than the silver solders is desirable.

Clad Metals and Alloys

In order to produce cheaper materials for construction but at the same time provide good corrosion resistance, such materials as nickel-clad and stainless-clad steels have been developed, the object here being "Save the surface and you save all." There are apparently certain applications for which such materials can be used to good advantage, and their further development in the future is to be anticipated[1].

This type of development is well-known in the aluminum alloys, in which a high-strength alloy is clad with the more corrosion-resistant pure aluminum. Other combinations of metals to obtain desired properties are illustrated by the aluminum cable with a steel core or the use of copper on steel to produce a combination of strength and conductivity. Steel sheet clad with aluminum has also been announced.

Bearings

The bearing problem has become more acute as machines have been designed to operate at higher speeds. This is particularly true in the automotive industry where the desire is to reduce the size of the engine, and as a result the bearing surface, to a minimum and at the same time to operate at higher bearing speeds and pressures. These conditions have rendered babbitt unsatisfactory for certain services. In order to meet this problem the copper-lead alloys have been developed, and more recently the cadmium-base alloys. Two types of cadmium-base bearings are now in service: Cadmium with about 1¼ to 1½ per cent nickel, and cadmium with relatively small amounts of silver and copper. These alloys retain their good properties up to higher temperatures than do the babbitts, and they are now being used to such an extent that the price of cadmium is materially increased and yet the supply is not equal to the demand.

Many of the accomplishments by the use of light alloys are too well known to require mentioning here. One of the latest developments is a free-cutting aluminum alloy. The still lighter alloys of magnesium are progressing rapidly, and some ten different alloys are in commercial use with strength ranging from about 21,000 to over 40,000 pounds per square inch, the alloys being produced by casting, by rolling or forging, and by extrusion.

Tuckerman[17] has pointed out the attractive properties of low-density and high modulus-density ratio of beryllium and, therefore, its apparent suitability for airplane construction, but he has also emphasized the high cost of beryllium and the difficulty of producing it in ductile form. While beryllium is finding a definite place in high-strength copper alloys, it is doubtful if pure beryllium can ever be produced at a cost which will permit any extensive use, even in airplanes.

Conclusions

High-strength heat-treated cast irons will be used more extensively, and since the modulus of elasticity has been raised from about 15,000,000 to as high as 25,000,000, some redesigning will be in order. Copper is an important alloying element in irons and steels, and its use for increased strength is increasing rapidly. Thick plates of hard chromium will be used more extensively to resist severe wear. Hardening by nitriding should find more use now that its advantages and disadvantages are known. There should be a reduction in the price of stainless steel when some patents expire in the near future, and as a result this type of steel should find still more extensive use.

Alloys of low thermo-elastic coefficient and of high yield strength for elastic elements in instruments are being developed and should be of great value, for example, in instruments used in aviation. The formation of alloys by electrodeposition should show marked advances in the next few years, because alloy plates may be superior to pure metal plates much as in the cast and wrought condition. Combinations of metals and plastics make some very attractive products, and this field of work may be expected to advance, and metals are being coated with plastic for protection and appearance.

Machine tools are being made to give improved service and are being designed for special jobs. For example, one large manufacturer recently stated that 60 per cent of all machines sold by his company are of special design for particular jobs. This is in line with the general theme that the future in metals will be one of great specialization and keen competition. That others share this opinion is shown by the following quotation from a recent paper by Dr. Francis C. Fray[7], director of research, Aluminum Co. of America: "Competition among the metals will become more severe, and the

(*Concluded on Page* 111)

Scanning the Field . . . FOR IDEAS

MATERIALS OPEN NEW FIELDS

MODERN engineering materials are driving the time-honored garbage can out of existence. Replacing it is an electrical device to be installed beneath the kitchen sink for the purpose of grinding waste food into a pulp and quickly disposing of it through the drain pipe into the sewer system. Shown in *Fig.* 1, the machine is driven by a quarter-horsepower motor and embodies materials that withstand the abrasive action of grinding as well as the corrosive action of various food wastes.

Housing, motor couplings, control handle and a number of the internal parts are Zamak die castings. These zinc alloy parts are characterized by their tensile strength and surface hardness, and also are corrosion resistant. Aluminum bronze die castings are employed for the propeller, shredder housing and strainer disk. The first shredder element, which breaks up the refuse, is made of cutlery stainless steel; the lower shredder is Carboloy, a material that approaches the hardness of diamond in addition to being corrosion resistant.

Brastil, a bronze alloy with excellent bearing characteristics combined with high tensile strength and corrosion resistance, has been selected for the main bearing of the rotating element. Supplementing these metallic materials is a synthetic substance known as DuPrene which serves as sink gaskets. This possesses the desirable characteristics of rubber together with ability to withstand the action of oil and grease.

The unit, developed by General Electric engineers, is clamped to the sink, the gasket sealing against leakage and also cushioning the mechanism to obviate vibration. An adjustable bracket at the floor aids in supporting the unit and also is cushioned to prevent transmission of vibration to the floor.

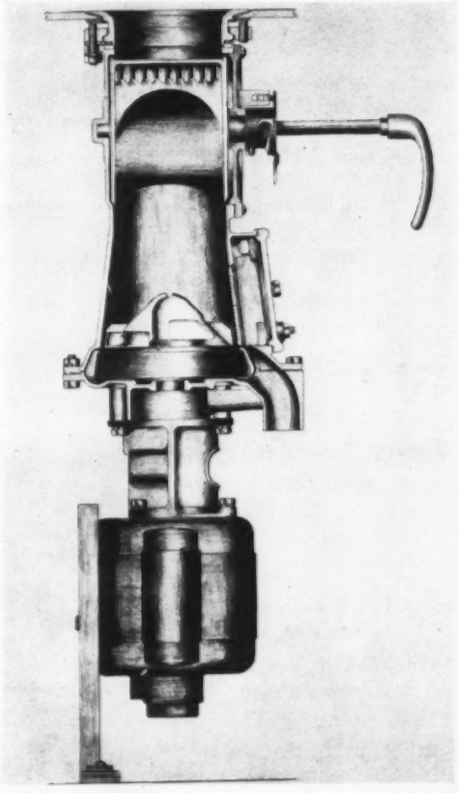


Fig. 1—*By judicious selection of engineering materials the designers of this kitchen waste disposal unit have reached a new goal in mechanization*

Without present day metallurgy, this device designed in the interests of sanitation could not have been developed. Moreover, the unit typifies the increase in mechanization of domestic equipment. The idea involves the rotating action of a propeller which forces the waste outward against the first shredding element mounted on the inside of the housing. Large pieces of refuse are reduced in size and fall into the lower shredder to be ground to a pulp. The resulting residue then passes into a revolving strainer disk through which it is forced centrifugally into a chamber below and around the flywheel. Fins on this member carry the pulp by centrifugal action into the outlet passage connected to the drain line. Water from the faucet flowing

through the unit during the grinding operation thoroughly flushes the waste down the drain.

BORON OVERLAYS RESIST WEAR

WEAR resistant overlays of metallic boron crystals now are a reality. By utilizing a nickel alloy which has been impregnated with a definite percentage of the newly-developed crystals, a smooth abrasion and corrosion resistant cast-on protection is obtained. This accomplishment is made possible by the development of a different type of boron crystals, containing no carbon, produced in the laboratories of Colmonoy Inc., Los Nietos, Calif. The process and material possess extensive possibilities; *Fig.* 2,

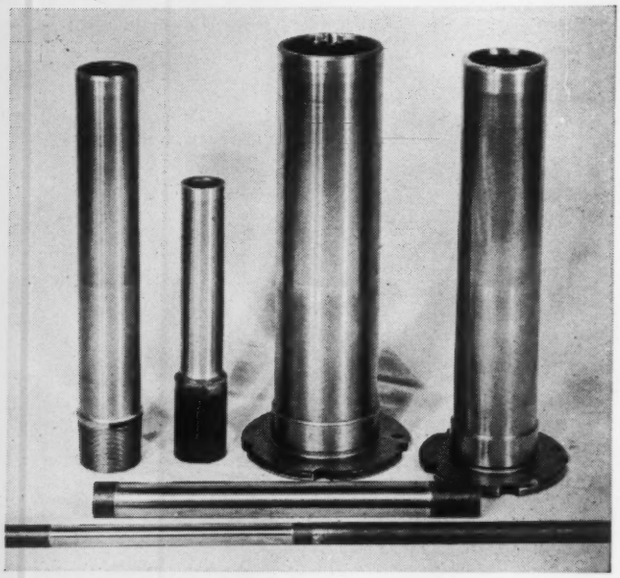


Fig. 2—Sleeves and shafts are overlayed with metallic boron crystals to provide an abrasion resistant surface

for example, shows a group of overlayed sleeves and shafts. Other machine parts that have been benefited by the innovation include bushings, agricultural implement members, etc.

COMBINING PLASTICS, DIE CASTINGS

PLASTICS and die castings have been combined, *Fig.* 3, to produce a part that sets a new mark in the possibilities of combining metallic and nonmetallic materials. Tenite is molded over a zinc core by the rapid injection process, by Die Casters Pty., Ltd. of Australia, achieving new beauty and utility in a motor car door handle. The smooth colorful appearance of the plastic is coupled with the strength of a die casting in a development that will no doubt have far reaching application. Here is an idea that is well worth considering. Tenite, a thermoplastic molding material made from cellulose

Fig. 3—Die castings encased in a smooth, colorful plastic furnish a new and important attainment in design

acetate, is a product of the Tennessee Eastman Corp., Kingsport, Tenn.

RUBBER MAKES AIR SPRING POSSIBLE

RUBBER springs inflated with air make possible an entirely new principle of automobile suspension. Invented by R. W. Brown, Firestone research engineer, the idea utilizes a rubberized fabric bellows (1), *Fig.* 4, inflated to carry the desired load, in communication with an air reservoir (2) through a valve (3) and

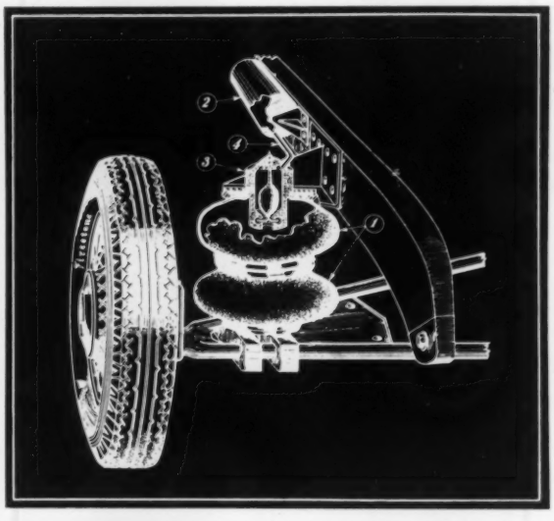


Fig. 4—A rubberized fabric bellows inflated with air serves both as a spring and a shock absorber

tubing (4). The bellows operates automatically in conjunction with the air reservoir by means of the pendulum shock absorption valve.

When the pendulum is vertical the passage of air from the bellows to the reservoir is unrestricted because the tip at the bottom of the pendulum engages the raised center of the valve disk, thus holding it open. After the wheels pass over a road obstruction the bellows extend, reducing the pressure, and the air flow between the reservoir and the bellows is restricted to provide the desired shock absorbing action.

The pendulum swings outwardly when the car is rounding a turn, permitting the valve disk to close the passage to the reservoir. This effectively increases the pressure in the rubber bellows as the additional load, caused by turning, is applied. Body roll and nosing down when heavy brake applications are made, are resisted by this action.

Another automotive development in which materials play an important part is the new Gabriel-Walex shock absorber, *Fig.* 5. The usual practice in the operation of this type of device has been reversed—the piston is stationary while the cylinder becomes the moving part. This

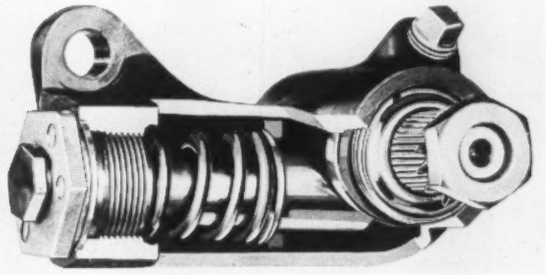


Fig. 5—Piston is stationary while cylinder serves as moving part in this new type shock absorber

latter member is machined from SAE 1112 screw machine stock, the crankshaft is drop forged from SAE 1025 steel and the five springs are SAE 1360 steel wire. A zinc alloy die casting is employed for the piston and the housing is a nickel iron casting. Balls in the intake and outlet ball checks are of high carbon chromium nickel steel. Copper gaskets seal the piston in the housing.

PUMPS FOR ACID USE HARD RUBBER

CENTRIFUGAL pumps successfully built of hard rubber offer evidence that designers usually can rely on materials to help them out of their difficult problems. A new Ace pump, *Fig.* 6, is made of acid-resisting hard rubber and embodies a simplified design. Developed for acid handling, the unit has a volute type casing, split vertically It is mounted on the base by means of a hard rubber-covered casting that acts as a chamber to catch drips from the stuffing

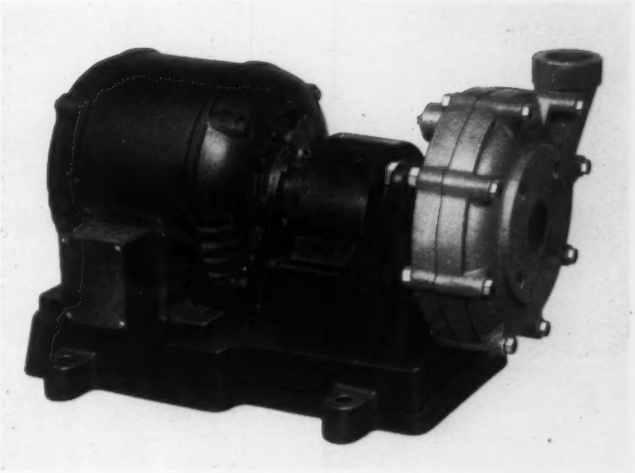


Fig. 6—Acid-resisting hard rubber has made possible a centrifugal pump of simplified design

box. A bypass for keeping the packing moist and cool is cored into the back casing.

An open type impeller is molded in one piece with the shaft. In addition to the usual blades on the face of the impeller there are eight low blades on the back of this part to reduce stuffing box leakage to a minimum. Shaft of the motor which drives the pump is tapered and pinned into the pump shaft.

ARC WELDED STEEL SETS PACE

STRENGTH and graceful lines—this combination is attained by the use of welding in the design of the Koehring shovel boom, *Fig.* 7. Constructed entirely of steel, arc welded, this large machine member has a smooth, even surface, unbroken by protruding connecting parts. Here is a case where appearance gives an impression of light construction, when actually the welded boom possesses greater strength per pound than its heavier looking counterparts. Tubular construction, another trend in boom design, also provides that modern touch which every designer seeks.

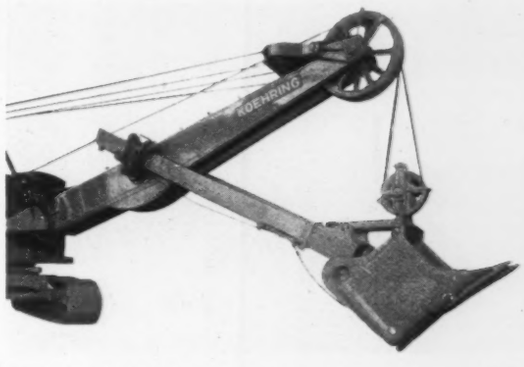


Fig. 7—No protruding connecting parts mar the appearance of this arc welded shovel boom

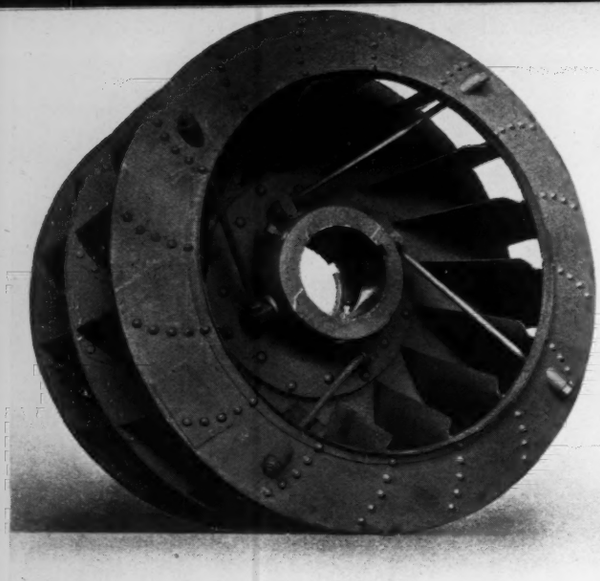


Fig. 1—Corrosion is resisted in this fan by nickel steel flanges and centerplate, and stainless rivets

Special Materials

By William C. Willard

BECAUSE of the very broad application of fans in industry, a presentation of the use of special materials in the construction of fans should be of general engineering interest. Special materials are incorporated in fan construction for several main purposes which may be listed as the following Selection Factors: (1) Increasing the value of allowable unit stresses at normal temperature; (2) resisting high temperature; (3) retarding or eliminating corrosion; (4) resisting abrasion; (5) reducing weight; (6) reducing fire hazard, and (7) dampening vibration.

The problem of selecting the kind of material from which to fabricate a fan should be studied carefully and the choice made on a basis of total cost of equipment for its expected life. When intended for use where exposed to one or more of the conditions of abnormal corrosion, abrasion, high temperature, etc., or where fire hazard or vibration may be encountered, too often the difference in first cost of a unit fabricated from standard material and that of one designed for fabrication from special material is made the basis of selection. The factors which should be considered are:

1. Difference in first cost between unit of standard material and one built all or part of special material.
2. Difference in life of machine of standard material and that of one of special material.
3. Cost of dismantling and reassembling equipment in order to renew or repair worn parts.
4. Loss of revenue and damage to other equipment and material in course of processing due to the shut-down while making repairs, etc.
5. Total expected life of the unit.

The various parts of a fan may be placed in three general groups when considering the use of special materials. These are, (a) all parts of the fan which come in contact with the atmosphere handled, (b) the fan housing only, and (c) the wheel or wheel shaft and bearings.

Initial Cost Varies Greatly

Initial cost between standard construction and special material varies most under condition (a). This difference in initial cost may vary from 200 to 600 per cent of the standard. For conditions (b) and (c), the difference in initial total cost is less.

Under severe conditions of either corrosion or abrasion, the life of a fan of standard steel may be only a few weeks or months. As an example, a fan of special material handling fumes from a plate-pickling tank has a life of three years and costs 3¼ times that of a standard steel fan. The life of the latter fan in the same service is three months. Considering initial costs and the labor cost of one installation of the special-material fan compared to nine installation costs of the standard fan, the ultimate cost of the initially more expensive special-material fan would be less than one-fifth that of the fan of standard steel.

SUBSTANCES handled by the machine and the conditions of use of the equipment considerably complicate the choice of materials. Mr. Willard, chief draftsman, Buffalo Forge Co., shows in detailed manner in this first section of a two-part article how careful consideration of all factors in the design influences the selection of materials and how this selection may be made.

Open Door to Design Success

Part I

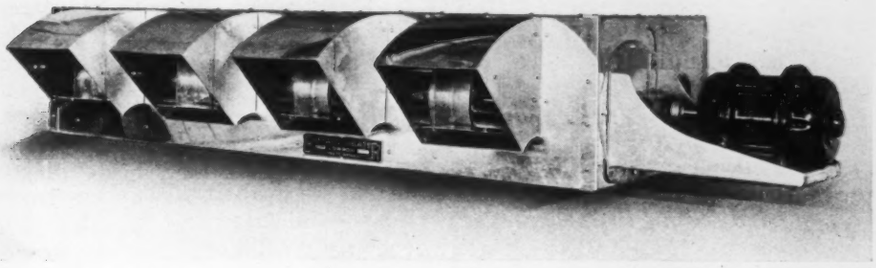


Fig. 2—Aluminum construction throughout is used in units for chemical plants and rayon mills

The labor cost involved in dismantling and re-assembling a fan in order to install a new wheel or other new part, varies with the size of the unit, the accessibility of the apparatus—whether in cramped quarters, mounted overhead, etc.—and the facilties available for handling heavy parts. Each installation should be considered individually.

Loss of revenue and loss of product in process of manufacture also should be considered for each installation. For instance, in certain chemical industries when the exhaust ventilating fan shuts down, an alarm sounds and every employe must immediately vacate the building, thus completely stopping production.

By "total expected life" is meant the expected life as limited by the manufacturing process in which the fan is to be used. As an example, changes in automobile design are taking place so rapidly that the engineer responsible for plant design of several automobile body plants recently stated that the expected life of fans used in connection with paint spray booths was but four to five years. In that length of time changes in design and development in manufacturing processes will necessitate radical changes in plant equipment. At the other extreme would be a ventilating fan for a coal mine, the expected life of which would probably be 50 years.

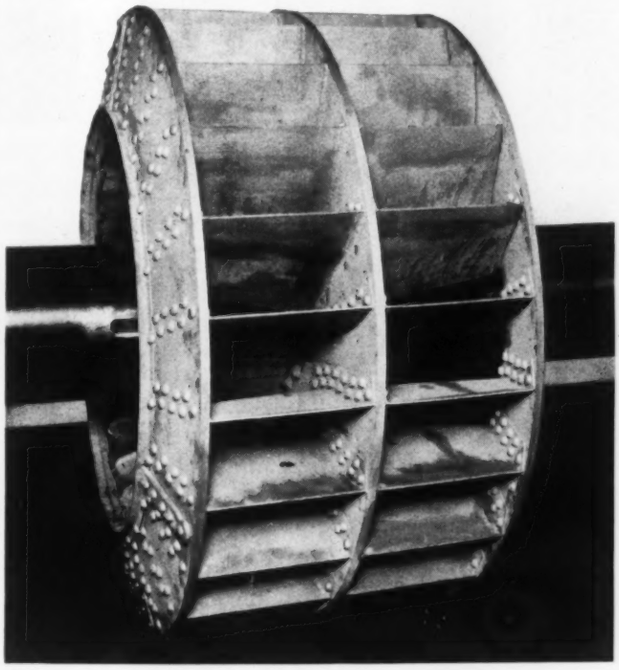


Fig. 3—High-strength alloy steel permits the construction of unusually rugged fan wheels such as the one shown herewith

Selection Factor (1) *Increasing Unit Stresses at Normal Temperature.*

The essential parts of a centrifugal fan may be described as those which rotate and those which are stationary, rotating parts consisting of the fan "wheel," the driving shaft upon which the wheel is mounted, the medium of connection between wheel and shaft, and the driving mechanism.

Stationary parts consist of the fan housing, with or without inlet boxes and the shaft bearings. Inlet boxes are that part of an induced draft fan which provide the connection between the fan inlets and the suction air ducts.

Fig. 3 is a photograph of the fan wheel used in a Boston central power plant. This wheel is approximately 6 feet in diameter and is designed for operation at a maximum of 1430 RPM. The periphery of this wheel travels at the rather surprising speed of 27,200 feet per minute. Stresses in all parts of the wheel exceed by several times those allowable in ordinary steel construction. The two flanges are ⅞-inch thick chromium-manganese alloy steel. The centerplate is 1 inch thick and of the same material. The double hubs are cast steel, with unusual double rivet-

ing between blades to flanges and centerplate. This wheel is mounted on a shaft 18 inches in diameter forged from .35 — .45 carbon steel.

Fig. 1 is a view looking into the inlet of another induced draft fan wheel. Again the hub is of cast steel. The flanges and centerplate are 3½ per cent nickel steel. Rivets are stainless steel having a composition of carbon .10, chromium 18, nickel 9.5. Tie rods and studs in hub contain carbon .35-.45 and manganese 1.1.

Unbalance Increases Stresses

Dynamic balancing of fan wheels insures initial quiet operation. But this equilibrium of dynamic forces may be short lived because corrosion and abrasion act unequally on the constituent parts of a wheel, causing progressive changes in equilibrium. A similar condition exists in many installations where neither corrosion nor abrasion are serious but where agglomerations of foreign matter accumulate on parts of the wheel. This produces unbalance in the wheel. Unbalance increases the unit stresses in all parts involved.

Where the danger of increasing dynamic stress exists, the designer of fan wheels must use a very modest value for his unit design stresses. Working stresses of 6000 p.s.i. in shear, 11,000 in bearing and 8000-12,000 in tension for commercial steel may be necessary. When working stresses above these values are encountered special high-strength alloys must be used.

Selection Factor (2). *Resisting High Temperature.*

A discussion of the structural changes which take place in steel at elevated temperatures is a complicated metallurgical one and will be dealt with here but briefly.

The 18-8 type stainless steel contain an iron-carbon alloy and are metallurgically termed Austenitic in character. In this condition the constituents are described as being in "solid solution" within the grains. When heated to temperatures between 900 and 1450 degrees Fahr., dissociation takes place and certain carbides, probably chromium carbide, are precipitated at the grain margins. Time and temperature are functions of this phenomenon. When it is necessary to operate continuously within the above-mentioned range of temperature, complete dissociation ultimately occurs and subsequent corrosion will depend upon the type of carbide precipitated. The surface of the metal may show no indication of corrosion, when suddenly failure may take place from granular disintegration. The addition of small amounts of some one of the metals molybdenum, tungsten, columbium and vanadium to 18-8 alloys appears to improve greatly its resistance to corrosion within the before-mentioned temperature range. Apparently these elements combine with the carbon of the alloy to form a carbide less affected by severe conditions of corrosion.

Limiting Carbon Simplifies Problem

When the corrosive agencies are weak, reducing the carbon content of the metal to a maximum of .07 is sufficient protection because it limits the amount of carbon available for precipitation.

When metal is being welded the temperature of the metal is at the melting point in the welding zone and is at room temperature some distance from the weld. At some point between these two temperatures the metal will have been subjected to the critical range of 900 to 1450 degrees Fahr. If annealed subsequently at a temperature of approximately 1900 degrees Fahr. and allowed to cool quickly in air, the precipitated carbides will be re-absorbed by the grains and the metal will be restored to its original structure.

Fig. 4 shows details of construction

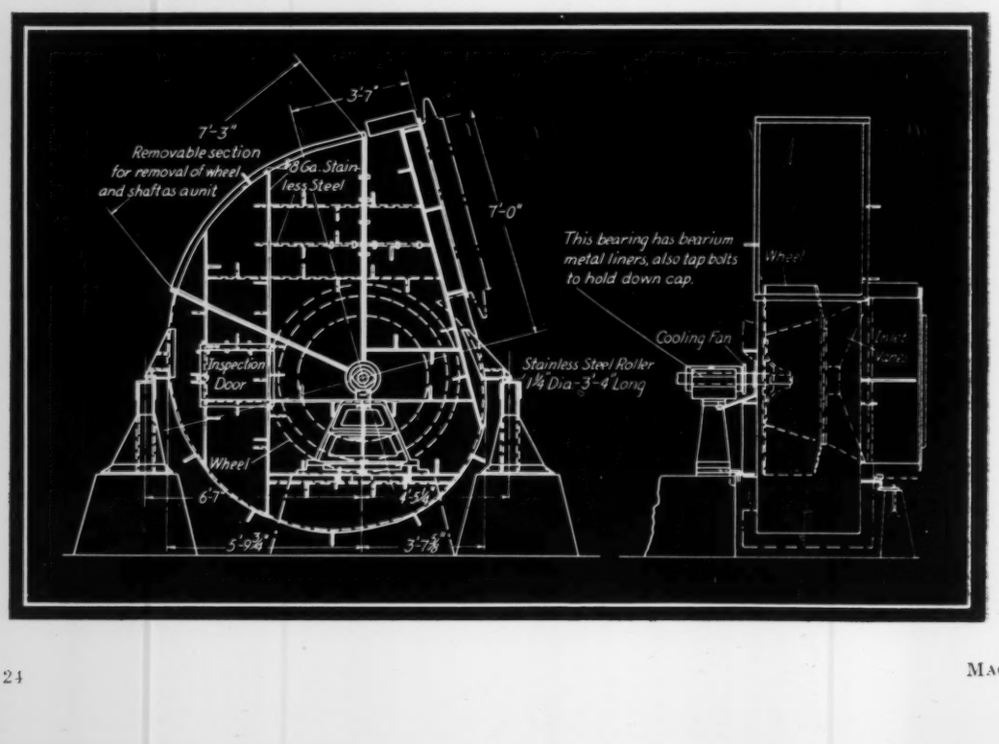


Fig. 4—Design details of housing handling highly corrosive hot gases

of a hot gas fan used in a fertilizer plant. The gas handled by the fan is very corrosive, containing phosphorus pentoxide, orthophosphoric acid, carbon dioxide, nitrogen and fluorine compounds. The temperature of this gas ranges between 900 and 1200 degrees Fahr.

The material selected for all parts of the fan which would come in contact with the gas was known under the tradename of KA-2-S-MO and its approximate chemical analysis was chromium 18, nickel 8, molybdenum 2-4, carbon not over .07. In designing the more highly stressed parts of the fan it was necessary to reduce allowable working stresses in order to meet the rigid "creep stress" specifications.

Parts of the fan housing not directly in contact with the corrosive gas were fabricated from a less expensive alloy having an analysis of

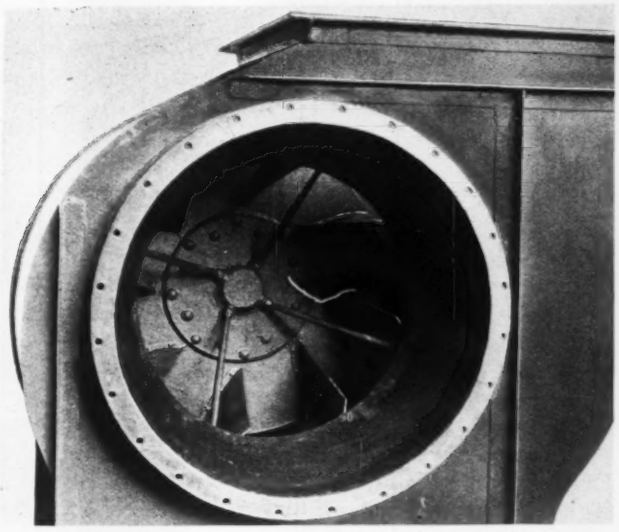


Fig. 5—All surfaces in contact with the gas handled are covered with rubber which is brought out to the inlet edge

4-6 chromium, .40-.60 molybdenum and carbon not over .25. The entire fan housing was to be covered with a five-inch thickness of insulation. Outstanding ribs of the second alloy 5½ inches high were welded to the housing for the dual purpose of acting as braces and forming a means for attaching the insulation. Some difficulty was encountered in structurally combining the two alloys because of the wide difference in coefficients of linear expansion.

The size of this fan housing, together with the amount of linear expansion encountered at the operating temperature made it desirable to mount the housing on rollers placed in a horizontal plane through the center line of the fan shaft, and to anchor the housing on its vertical center line against lateral movement and in such a way as to cause expansion parallel to the shaft to take place only in the direction away from the bearings.

In *Fig.* 6 the effect of elevated temperature upon the ultimate strength of steels of five different compositions is shown graphically. The materials represented are as follows:

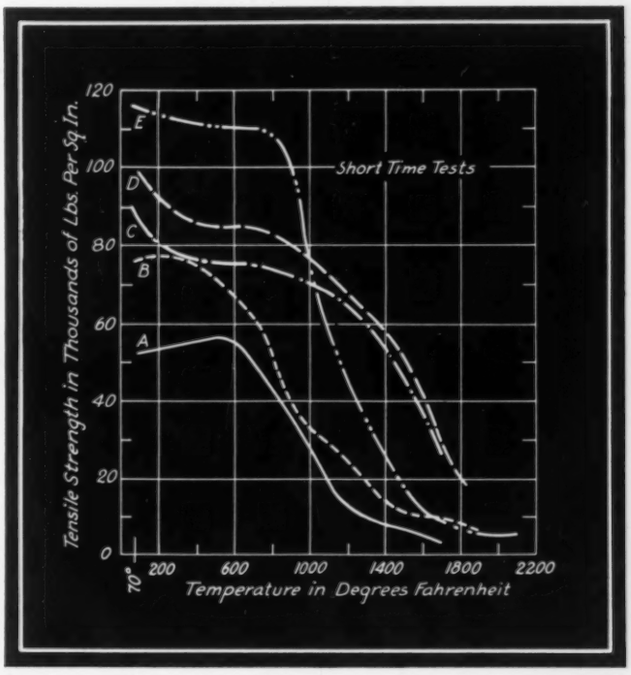


Fig. 6—The effect of elevated temperature upon the ultimate strength of steels of five different compositions

Curve A. Commercial sheet steel having carbon .10-.25.
Curve B. Carbon below .12, chromium 12-16.
Curve C. Carbon below .25, chromium 26-30.
Curve D. Carbon under .15, chromium 17-20, nickel 7-10.
Curve E. Carbon under .20, chromium 22-25, nickel 10-13.

Bearings of fans handling gases at temperatures from 900 to 1500 degrees Fahr. require special attention from the designer. Fans handling hot gases and designed without inlet boxes are of the overhung wheel type. Considering the fan just described, with a temperature of 1200 degrees Fahr. in the fan, the designer was faced with the problem of keeping the inboard bearing as far from the fan housing as possible because of the temperature and at the same time holding it as close to the housing as possible in order to keep shaft deflection to a minimum. The deflection was, of course, exaggerated by reduction of the modulus of elasticity of the shaft metal at the elevated temperature.

One feature favorable to design was the fact that the coefficient of thermal conductivity of the alloy steel of the shaft was about one-fourth that of carbon steel. Even so, it was considered unsafe to use the standard type of water-cooled babbitted bearing which is satisfactory for temperatures inside the fan of 750 to 850 degrees. The inboard bearing was lined with a special bronze containing about 30 per cent lead.

Selection Factor (3). *Retarding or Eliminating Corrosion.*

Corrosion is the result of chemical action caused by the presence of ordinary moisture, chemicals in concentrated or diluted solid, liquid

or gaseous form, or by gases at elevated temperatures.

A rather extensive list of corrosion-resistant materials is available. For ordinary moisture resistance, the cheapest construction is a standard steel fan wheel and housing, with wheel and inside of housing painted with a heavy coat of asphalt paint. This is effective only so long as the coating remains intact. It is used extensively in unit air washers and coolers of the highboy type. Numerous other moisture and acid resistant paints are on the market. A better grade of construction for this class of apparatus consists of galvanized steel casing painted on inside with asphaltum, and brass fan wheel.

Aluminum construction throughout is used extensively in chemical plants and rayon mills, the metal being resistant to sulphuric, nitric and acetic acid at room temperature. *Fig.* 2 is a photograph of a flat suspended type unit heater fabricated entirely from aluminum, with the exception of the fan shaft, coupling and motor.

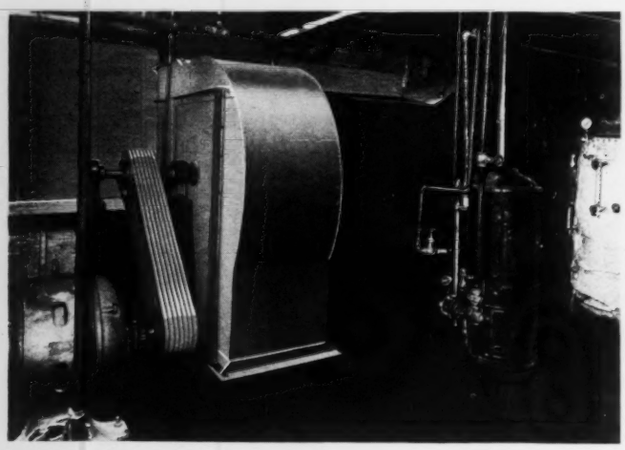


Fig. 7—Hydrochloric acid is handled by this unit which has all parts lined with rubber to prolong the life

Fans intended to handle fumes of sulphuric or nitric acid and of a design which can be sand cast, may consist of an alloy of lead and antimony in the proportion of 90-92 lead to 10-8 antimony. Being a low strength alloy, the maximum safe RPM of the wheel is limited to comparatively low values. Also, because of danger of distortion from its own weight, the maximum size of housing is limited. The result is that fans cast of lead-antimony alloy are available only for comparatively small capacities. Where available, they are satisfactory and their life is long. A 1/16 or 1/8-inch lead coating burned to all surfaces of a steel fan wheel has been used with some degree of success. Cast iron and cast aluminum wheels give satisfaction in many chemical processes.

By far the most successful type of construction in use at present for handling chemical fumes is the rubber-lined fan. This consists of an overhung wheel type of fan fabricated from standard steel or cast iron, all surfaces of the wheel, the end of the fan shaft, and the inside of fan housing are covered with rubber, and rubber covering also extending outward along the fan shaft to a point about an inch outside the fan housing.

Fig. 5 is a view looking into the inlet of a rubber-lined fan. It will be noted that all surfaces which come in contact with the gas handled by the fan are covered with rubber, the rubber furthermore being brought out to the edge of and wrapped around on the back of the inlet and outlet flanges of the housing. *Fig.* 7 shows an 80-inch rubber-lined fan which has been in service more than three years handling very corrosive hydrochloric acid fumes.

Rubber-lined fans are available in several grades and thicknesses of rubber. The consistency of the rubber may be hard or soft. The usual thicknesses of rubber coating are 1/8, 3/16, and 1/4 inch. Adhesion of the rubber to the steel exceeds 700 pounds per square inch. The only limit to the size of rubber-lined fans is the size of the available vulcanizing vessel of the rubber manufacturer.

Chromium Steels Resist Moisture

The chromium and chrome-nickel groups of alloy steels are available for resistance to moisture corrosion and also are useful in overcoming many problems of chemical corrosion. The effect of elevated temperatures upon the selection of materials of fan construction was discussed under the topic "Resisting High Temperature." Other metals of much merit in fan construction for resisting corrosion are brass and bronze, Everdur, and Monel metal. For sheet parts of wheels and housings fabricated from brass, the alloy known as Muntz Metal is commonly used. For cast parts, such as the arms of wheel spiders, where tensile strength is important, a cast alloy such as manganese bronze should be used.

Everdur is a high-strength nonferrous alloy of copper, silicon and manganese. Monel metal is classed as a nonferrous alloy containing 60-70 nickel and 25-35 copper. The remainder consists of small percentages of iron, manganese, silicon and carbon. Both of these alloys, brass, and a stainless steel with analysis chromium 22 to 25, nickel 10 to 13 and maximum carbon .12 are used extensively for the wrought parts of the wheels of fans used in connection with the centrifugal scrubbing of certain gases in the chemical industries. The hubs are usually cast iron. This is a severe service and the increased cost of the wheels fabricated from these special alloys is more than justified by the increased life obtained.

A discussion of the additional selection factors which must be considered in the specification of materials for fans will be presented in the second section of this article in the April issue of MACHINE DESIGN.

To Be Continued

Culled from Experience

Design Authorities Present Their Thoughts on Materials
Past Benefits—Present Progress—Future Possibilities

" . . . . . alloy cast iron advantageous."

By E. P. Burrell

A FEW years ago, cast iron with a tensile strength of 35,000 pounds was considered satisfactory, while today foundries are producing alloy iron regularly with strengths of 55,000 to 65,000 pounds. The introduction of alloys such as nickel, molybdenum, chromium, etc., with a large steel content, has resulted in the production of a refined structure free from blowholes, much harder, and of nearly double the stiffness. Where mass is not required, these irons permit substantial reduction in section and weight.

Special alloys mixtures that lend themselves to heat treating may have their tensile strengths increased to 100,000 pounds, with only some 2 or 3 per cent elongation. Such castings replace more expensive materials such as malleable or steel castings. It may be possible that some process similar to that of nitriding will be developed to produce a surface of high wear resistance.

While it is believed that there will be little change in the future in the types of structural steels which have their place in machine construction, many improvements may be expected in alloy steels. Steels are required with superhard surfaces for wear but devoid of a brittle structure. It is probable that the process of grain refining, starting at the mill, will result in greatly improved alloy steels for gearing and shafts, as well as many other machine parts. Such alloys when subjected to hardening and heat treating will give more uniform results with greater freedom from distortion, thus removing many of the worries of the designer, as well as the producer, of machine elements.

" . . . . . magnesium assists weight reduction."

By L. R. Tufts

EXTRUDED aluminum alloys and magnesium, or Dowmetal alloys in cast form have proved most useful in recent designs of our machinery. Cast Dowmetal has assisted greatly in the reduction of weight of numerous

E. P. BURRELL
Director of Engineering, Warner & Swasey Co., Cleveland.

L. R. TUFTS
Engineer, Dexter Folder Co., Pearl River, N. Y.

U. A. WHITAKER
Director of Development and Design, The Hoover Co., Canton, O.

HAROLD VAN DOREN
Harold Van Doren & Associates, Toledo, O.

reciprocating parts, as well as reducing the weight of other parts which must be frequently handled by the operator of the machines. In the latter case, the use of this light material sometimes means the difference between a unit that an operator can handle and one which he cannot because of its weight.

The ease with which the stronger aluminum alloys can be obtained in extruded form has simplified the manufacture of a great many more or less intricately shaped pieces which could not have been produced in previous times.

" . . . . . more efficient materials needed."

By U. A. Whitaker

THERE have been so many recent improvements in materials that it is difficult to say which are the more important. It is the writer's view, however, that the lightweight metals such as aluminum and magnesium and their high strength alloys are coming more and more into the picture in the design of machinery because of the very great weight savings that can be effected by their use. The numerous plastics that have been developed in addition to Bakelite also seem to be coming to the front at a very rapid pace because of the light weight of these plastics, and also because these parts can be molded to such precision that little labor is required to complete them, thus effecting considerable cost savings.

It is comparatively easy to state what would be desirable in the line of future materials developments, but to offer suggestions as to desirable improvements that at the same time lie within the realms of possibility is much more difficult. The continued development of the lighter alloys to improve their strength and especially their fatigue resistance, and the refinement of production processes so as to get costs down would be most desirable. The further development of the heavier materials such as steel in order to increase their physical properties so that weight would be reduced, would also be of assistance.

Stainless steels have been of a great deal of interest. On account of their high price and the great difficulty in working, their use has been limited to a large degree. Naturally the development of a stainless steel that could be worked easily and could be sold at a figure more nearly the cost of ordinary steel plus plating would be of great value.

I believe the trend will be more and more toward more efficient materials — that is, materials having greater strength for a given weight. Such materials as cast iron, wood, etc., will probably be used in a decreasing proportion because of their lack of dependability and on account of their weight as compared to other materials of equal strength.

Other recent trends would seem to indicate an extensive use of flexible transparent plastics or glass, better materials for elimination of noise, a much more extensive application of the rare elements in the alloying of our more common metals, and new forms of insulating materials. Rubber and similar compounds will probably continue to show unexpected characteristics and thus fill a larger place in our list of materials of construction. Based on past experience, it seems safe to predict that our metallurgists will continue their development of steels and associated products. Progress in this line always results in more extensive use of these materials.

" . . . . . plastics found ideal."

By Harold Van Doren

THE UREA-FORMALDEHYDE group of plastics, long known as a laboratory phenomena, constitutes the first practical development of thermo-setting plastics, (as opposed to the permanently plastic resins such as the cellulose acetate group) all of which are susceptible of brilliant coloration. Although their rich range of colors is exceedingly valuable in the preparation of many small decorative articles, their interest to the progressive engineer might have stopped right there if they had been confined to such applications. But gradually these materials have been made in much larger pieces, and have been found ideal as housings for machines ranging from meat choppers to adding machines and retail store scales. The extreme lightness, infinite range of colors, permanently glossy surface and adaptability to all kinds of design treatment of these plastics have taken them suddenly out of the small accessory and gadget class, and brought them to the consideration of the engineer for a large variety of parts.

Although molding technique has lagged behind chemical research, in the manufacture of both phenolic and urea types, it is rapidly being improved. The recently announced beryllium copper molds may greatly cheapen mold costs — a distinct barrier to progress — and molding presses of greater flexibility are being developed. But the chemists still have a job to do in improving the flow qualities of the thermosetting materials to the point where they will remain plastic long enough to fill out a large piece before "setting up;" there is also work to be done in producing materials which can be molded in thicker sections.

Fig. 1 — Moisture resistance, light weight, and permanently attractive appearance were requirements in the design of this hair clipper

Taking Advantage of Molded Plastics

Choosing the Proper Material—I

Properties Cover Wide Range—II

By Edward F. Bachner
Chicago Molded Products Corp.

By L. W. Seybold
Reynolds Molded Plastics

Part I

PRACTICALLY every problem of design hinges on, or is affected by the choice of the material or materials to be used. To illustrate the selection of the proper plastic material for a given job, let us take a few concrete designing problems, and see how each was solved in actual practice by different materials.

The first of these is Chicago Flexible Shaft company's Clipmaster, shown in *Fig.* 5. This is an electric motor-driven device for clipping animals, and is subjected to hard and abusive service.

Since the motor housing may well serve as the handle, the first requirement is completely adequate electrical insulation. At the same time, the operator's hand must also be insulated from the motor's heat. Lightness is necessary to avoid tiring the operator. The conditions under which an animal clipper is used require that the material possess strength and resistance to shock. And, of course, sales competition makes economical production essential.

The form of the required parts, the need for accuracy, and the requirement of economical production, clearly indicate that the motor parts should be molded. In consulting our tables, similar to the one shown in the article on page 31, we find that most plastic materials have excellent electrical and heat insulating characteristics, so that after we have satisfied these requirements we still have a wide

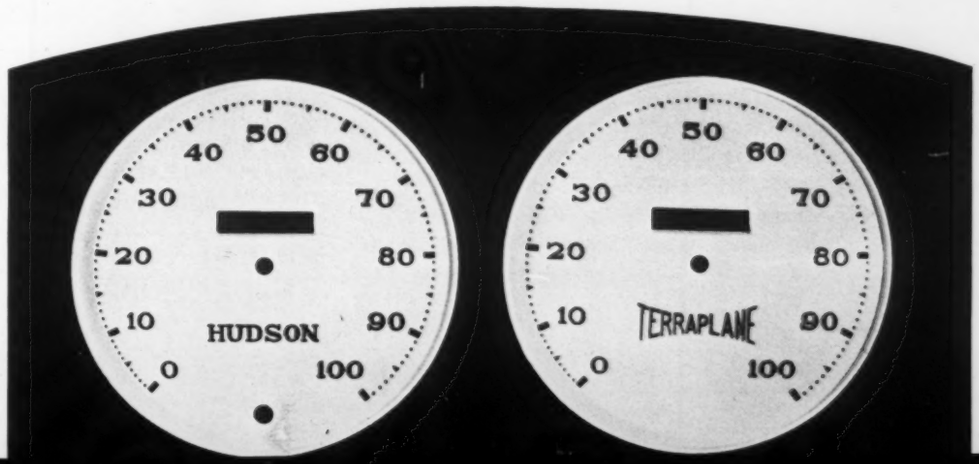


Fig. 2—Thickness of plastic material for speedometer dials is carefully calculated to give just the right degree of translucence and diffusion and provide ready legibility

range of choice. The required lightness, too, is found in many materials. But when we come to the problem of ability to withstand severe abuse, we find that our needs are most completely fulfilled by Impact Bakelite.

In this material the plastic is reinforced by canvas fiber, giving not only strength but high resistance to physical shock. At the same time, the insulating property, specific gravity and the high degree of heat insulation are completely satisfactory. *Fig.* 5 shows the completed Clipmaster, with its molded parts as it was actually produced.

At first glance, the hair clipper, *Fig.* 1, produced by the John Oster Mfg. Co. would seem to present a problem almost identical with the foregoing. Yet in actual practice different materials were used for all molded parts. Let us examine the requirements and see why.

As in the previous example, we have a light compact motor-driven appliance, in which the motor housing serves as the handle. The same problems of electrical insulation, heat insulation and lightness are present.

Same Strength Not Needed

Our previous analysis showed that these characteristics could be had in a number of materials so we go still further in this case. Strength is important, but because the hair clipper is considerably lighter and more compact than the animal clipper, the same high degree of strength is not needed.

A more important consideration in the designing of this appliance, however, is the fact that it is, in effect, a toilet article, and requires appropriate appearance. Again, a number of plastics provide a rich, lustrous finish. But since the exposed metal parts are to be chrome plated, a black material affords the most effective contrast. This narrows our choice down to the phenolic materials, and after careful consideration, Durez was selected — double dyed base black Durez takes a high polish and insures, even with hard handling, a lasting finish. Further, it supplies a fine contrast to the metal clipper knives and guide. It has good moisture resistance, and is light in weight.

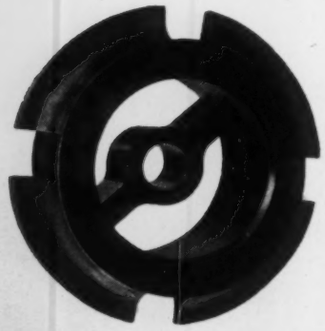


Fig. 3 — *Complex shapes may be molded in plastics to produce a part that is immediately ready for inclusion in the final assembly*

Having now chosen a suitable material, what about design? Little change of design in the handle is required, except that the formerly loose parts which insulated the motor from the metal handle have now become an integral part of the molded handle, eliminating troublesome assembly and insuring air space between the handle and motor for more effective ventilation and insulation. The shaft bearing support now also becomes integral with the housing and into it we mold a bronze bushing—another assembly problem solved. Instead of the perfectly smooth handle, likely to slip or twist in the operator's hand, we incorporate longitudinal beading which both adds to the appearance and aids the grip. Without adding weight, clipper-head walls can be made thicker and thus give it sturdier support for the actuating lever stud, which is molded in place—still another troublesome assembly avoided.

By way of contrast, let us take an entirely different type of designing problem. Stewart-Warner Corp. requires dials for the speedometers manufactured for the Hudson Motor Corp.

Fig. 4—*Strong accurate threads such as these are easily molded without extra operations in parts of phenolic material*

These must be beautiful and modern, in keeping with the latest trends in motor car design. They must also have clear, legible figures, readable at a glance, day or night. And they must be uniform and accurate, for easy assembly.

The need for accuracy and attractive form at once indicate the advisability of molding. The designer finds that illuminating the dial from behind provides maximum legibility at night, at the same time lending a modern touch.

Our table tells us that translucence is a property of the light colored urea plastics. And after a careful study of the interior design of the cars, and the many colors available, we select ivory Plaskon, on which we apply the figures in a darker contrasting color. The thickness of the material is carefully calculated, to give just the right degree of translucence and diffusion and to provide instant legibility without glare. As a result, we have panels as strikingly beautiful as they are practical, *Fig.* 2.

Still another totally different problem is presented by the applicator nozzle produced for the Scholl Manufacturing Co. The obvious requirements—finish, strength, accuracy, and resistance to certain liquids—can be met by several materials. But there is one major difficulty; there must be an opening through the nozzle and the small end is curved. It is impossible to mold the required curve, since the core could not be withdrawn. Study of the molding operation shows only one practical solution—to mold the nozzle straight, and then form it to the desired curvature.

But the resin compounds which have been used in the previous examples are thermo-setting materials and, once molded, cannot again be reshaped. So, consulting our table, we turn to the cellulose materials, and in Tenite we find just what we want—a thermo-plastic material—which has every essential quality mentioned above, and in addition, can be reformed again, after molding, by the application of heat.

The designer who is considering the use of plastics can take no sounder step than to consult a reliable custom molder early in the development of his design. Because of his close familiarity with the many plastic materials the molder can save the designer much time and effort by furnishing an unbiased, authoritative opinion as to the best material for the job at hand. He can also, in many instances, suggest slight changes in the design which will materially lessen the cost of the molded part without in the least impairing its efficiency.

Part II

MOLDED plastics have a place on almost every article of manufacture, replacing wood, metal or glass, substituting for a less satisfactory part, or serving as a dress-up feature. Plastics are now available which resist heat, cold, moisture and most acids, with high dielectric properties, with great strength-to-weight ratios, and in the widest variety of finishes and colors. Many results formerly thought to be impossible of attainment with plastics are common today; tomorrow still further progress may be expected. So rapidly has the art advanced that it may be well to inquire about it from time to time; since your last inquiry, your "impossible" problem may have been solved.

Production of synthetic plastic moldings made of phenol, cellulose acetate and urea bases, recognizable under the trade names Bakelite, Beetle, Durez, Plaskon, Resinox, Tenite, etc., can be applied to practically any molding deemed possible today. The properties, uses, and present state of the art on each of these molding materials are described in this article.

In the design of a plastic article the following details should be considered:

INSERTS: Threaded metal inserts, contacts, terminals, wires, inlays, nameplates, etc., may be embedded in the molding process, making later assembly easier, stronger and less expensive.

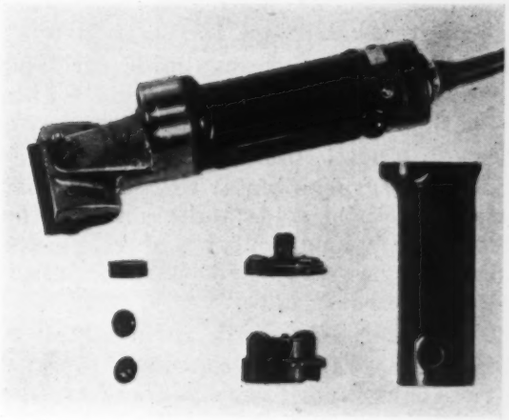


Fig. 5—Strength and high resistance to shock is provided by reinforcing with canvas fiber

TAPPING, PUNCHING, RIVETING: Most moldings can be drilled, punched and tapped but they are more satisfactory when threaded metal inserts are used instead. Nails cannot be driven into a molding. Holes can be molded in, and drive screws or rivets used, but such specifications must be expertly designed.

THREADS: Strong, accurate threads are easily molded without extra operations.

UNDERCUTS, SIDE HOLES: Molded pieces set hard in the mold. Cavities and holes therefore should be straight, without undercuts or projections that prevent straight, vertical ejection from the mold. Undercuts are possible in split molds, but are more costly. Sideholes are practical, but they slow operations and cause breakage. Avoid sideholes if possible, particularly slanting and oblique holes.

MACHINING: Machining a molded piece is practical but laborious, though occasionally a machining operation eliminates a split or otherwise complicated mold.

WALL STRENGTH, THICKNESS: Wall thickness should reflect the tensile strength of the molding material used.

TOLERANCES: Depending on the material, tolerances can usually be held to plus or minus .002-inch on small dimensions, and .004-inch on larger. Unless necessary, avoid closer limits. Ordinarily, in precision molding, .004-inch is the accepted tolerance. While not as strong as equivalent cross sections of metal, moldings are not brittle and stand almost unbelievable stresses when reinforced with ribs and fillets.

DIELECTRIC: Depending on the molding material used, dielectric strengths run to 1000 volts per mil, plus recently improved arc-resisting qualities and longer life under electrical fatigue, making moldings suitable for severe

applications such as high-tension ignition, heretofore impractical.

HEAT: Moldings are available for temperatures up to 500 degrees Fahr. and higher for short periods.

WATER: Plastic moldings are available with almost any degree of water resistance, and with resistance to most acids and chemicals such as alcohol, acetic acid, butyl and ethyl acetate, acetone, 10 per cent hydrochloric, etc., with bleeding or etching effect.

WEATHERING: Moldings are available which will not fade, craze or warp under weatherometer tests equivalent to two years of exposure to wind, rain, sun and frost.

ACOUSTIC: Plastic moldings do not transmit or amplify sound as does metal.

SINGLE OPERATION: Most moldings come finished from the mold, requiring no further operation except the removal of fins. Thus complex assembly jobs become single operations by combination of related pieces, with no buffing, plating or coating necessary.

WEIGHT: Moldings weigh approximately ¼ as much as glass, and 1/6 as much as iron, steel, zinc and brass, thus reducing dead weight in hundreds of machines.

COLOR, FINISH: Colors are not applied; they extend through the molding and cannot chip, peel, or wear off. Moldings take exactly the finish of the polished, plated or engraved mold used. They have a permanent mirror lustre, free of waviness, requiring no buffing or polishing, and actually improving with use.

Bakelite

The original and one of the most widely used molded plastics is Bakelite. It is made of phenol crystal (carbolic acid) and formalin (formaldehyde gas dissolved in water). Under definite, controlled conditions these two combine chemically. In the primary state the resulting phenol resinoid softens at moderate temperature and is soluble in certain solvents, but further heating hardens it beyond all softening, gives it great strength, and renders it impervious to the action of heat, cold, water, oil, alcohol and most acids.

Because of its high final finish, depth of lustre, color, and resistance, Bakelite finds use in ignition coil cases; furniture and truck casters; electric plates, panels and parts; parts for oil drilling equipment; molded commutators; silk and rayon manufacturing equipment; steaming bobbins; shuttles, etc.

To meet such differing requirements, many Bakelite formulas have been developed. Each uses the basic phenol molding material in combination with a filling agent—woodflour, asbestos, mica, graphite, paper fabric—to achieve the desired finish, hardness, toughness, and water, heat or electrical resistance.

Woodflour-filled Bakelite is used where lightness, superior finish, strength and fair electrical properties are required. Stock colors are black, brown and several attractive mottle effects. On demand, colors to match samples are available . . . Mineral-filled Bakelite is somewhat more difficult to mold and does not possess quite so brilliant a finish, but is better adapted to uses requiring high heat and weather resistance. . . . Impact Bakelite is still more difficult to mold, some pieces requiring preforming in special 5000 pound per square inch presses. These materials have great impact resistance, ranging from 5 to 30 pounds per square inch.

High and low values of woodflour Bakelite are given in the accompanying table.

Durez

This thermo-setting plastic is one of the most successful and widely used. It is available in practically any color excepting white. Colors are light-fast, but the lighter tones will fade slightly in direct sunlight. The finish of Durez is sleek and lustrious, attractive to the eye and pleasant to handle.

Durez is made in many formulas, adapting it to a wide variety of purposes. It is used where low water absorption is vital; it may be immersed in water and solvents, and subjected to steam, without appreciable change or absorption; both in color and dimension it resists acids, alcohol and alkalies; it has great impact and dielectric values; it may be had in formulas that will withstand 500 degrees Fahr. indefinitely and higher temperatures intermittently, permitting its use on electrical appliances and cooking utensil handles as well as numerous industrial applications. New formulas for new uses are constantly being developed.

Fig. 6—A number of accurately molded parts go to make up this windshield wiper

Most nearly inert of molding materials, Durez

Properties of Typical Molding Materials

	Bakelite	Durez	Resinox	Plaskon	Beetle	Tenite
Specific gravity	1.34-1.52	1.27-1.73	1.34-1.8	1.47	1.46	1.27-1.37
Weight, gms. / cu. in.	22-25	20.6-28.3	8.5-14	24	23.9	20.7-22.4
Tensile strength, lbs. / sq. in.	6000-11,000	6000-10,000	.....	8000-13,000	6400-9400	4300-5000
Compressive strength, lbs. / sq. in.	25,000-36,000	25,000-30,000	.....	25,000-35,000	25,000-30,000	12,000-16,000
Impact strength, ft. lbs. / sq. in.	1.00-3.5 (b)	0.14-0.50 (a)	.....	5-10 (a)	2-2.4 (Izod)	1.2 (Izod) 5.2 (Charpy)
Flexural strength, lbs. / sq. in.	10,000-20,000 (transverse)	10,000-11,000	7000-13,000	10,000-14,000	.....	.....
Modulus of elasticity lbs. / sq. in.	$1.0\text{-}2.5 \times 10^5$	.....	.....	1,555,000-1,655,000	1,200,000	.....
Hardness	.....	3-4 (Moh)	....	48-54 (Brinell) 89 (Scleroscope)	88 (Sclero-scope)	55-60 (short test: pure lead 2, quenched steel 100)
Elongation, per cent	.....	.....	.....	.....	.....	30-35
Dielectric strength, volts per mil. instantaneous, 60 cycles	300-500	350-600	.....	300-550	500	700-800
step-up, 60 cycles	250-400	.....	.....	.....	300	.....
Dielectric constant	.....	.....	.....	.....	7-10	.....
10^2 cycles	4.5-8	.....	.....	6.4	.....	.....
10^6 cycles	4.5-8	4.5-5.5	.....	6.3	.....	.....
60 cycles	.....	.....	.....	7	.....	.....
Power factor, per cent 10^3 cycles	4-15 (c)	.....	.....	2.4	.....	.....
10^6 cycles	3.5-10 (c)	3.5-5	.....	3	.....	.....
60 cycles	.....	.....	.....	3	.....	.....
Radio	.....	.....	.....	.....	3.78	.....
Audio	.....	.....	.....	.....	4.54	.....
Volume resistivity, ohms / cm	$10^{10}\text{-}10^{12}$	$10^{11}\text{-}10^{12}$	.....	$2\text{-}2.8 \times 10^{12}$	14.4×10^5	.....
Specific heat, gm calories / gm / degree Cent.	0.3-0.4	.....	.....	.....	.....	.....
Coefficient of expansion, per degree Cent.	0.00003	.....	.....	.....	.....	.....
Heat resistance, degrees Fahr. continuous exposure	.....	400-470	.....	150-160	.....	.....
intermittent exposure	.....	550	.....	250	.....	.....

(a) Tentative or standard ASTM tests.

(b) $\frac{\text{Energy to break test piece}}{bd^2}$, with b = width and d = thickness measured in direction of force application.

(c) The molding material should be protected against absorption of moisture from the air if these values for power factor are to be maintained. Proper preheating before molding gives improved electrical properties.

is used extensively in decorative articles. Its greatest field, however, is in industrial uses where close tolerances and resistance to change of dimension, color, finish and physical properties are demanded.

Early applications of Durez were on automobile ignition systems, and as switch and conduit box parts and commutator parts. Now it is used for items such as valve handles, and desk telephone sets. Because it is inert it lends itself admirably to the making of small machine housings, clock cases, electric toaster and mixer parts and bases, etc.

Durez may be compounded to take its final, lustrous finish in the mold or in subsequent grinding and polishing. Though it machines with some difficulty, holes may be drilled and threads tapped in. Durez takes metal inserts and positions them rigidly. Strong, accurate threads can be molded in.

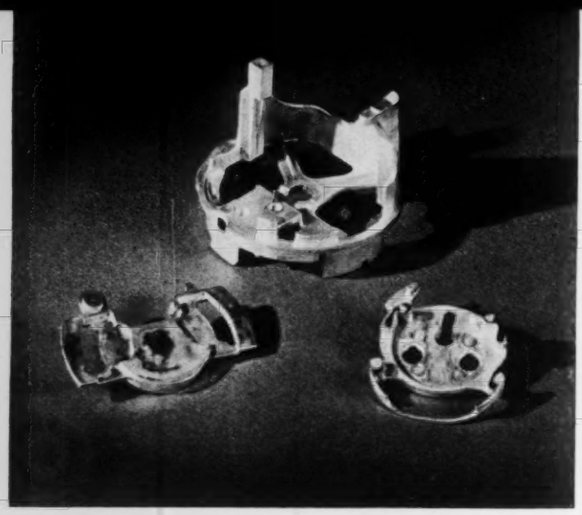
This material does not crack or craze under severe weathering, adapting it to application on display machines and equipment used out-of-doors, and for out-door electrical insulation.

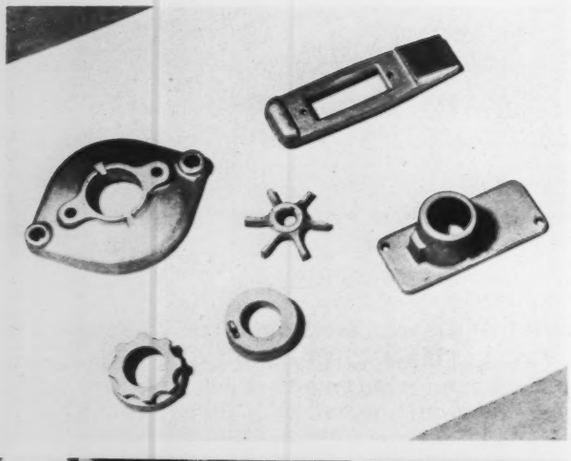
Woodflour-filled, mineral-filled, impact and special Durez compounds are available. These adapt the material to innumerable industrial uses. The table gives physical characteristics.

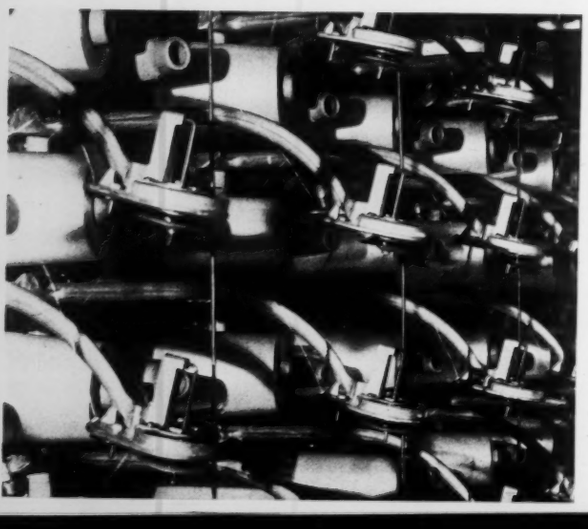
Resinox

Resinox is a phenol-formaldehyde plastic with an exceptional range of properties. It is available in standard blacks, browns, and reds, and an attractive assortment of pastel tints. Resinox is light in weight; has great strength and extremely high torque strength; extreme shock re-

(*Continued on Page* 112)







Die Casting

By Allen F. Clark

THE early experience of many of the older engineers with die castings was often disappointing, sometimes even tragic. In those days lead and tin were alloyed with the basic metal in considerable proportions; now they are diligently kept out. The American Society for Testing Materials limits these two impurities to a maximum of 0.007 per cent lead and 0.005 per cent tin. Die castings alloys are now practical engineering materials, developed to be used intelligently and to be trusted. High purity zinc alloys, perfected processes for die casting the lighter alloys of aluminum and magnesium, and achievements in brass die casting enable the designer to specify these alloys for many parts in distinctly new fields; thus die castings are serving an ever expanding group of machine designers.

Society of Automotive Engineers standards for zinc alloy die castings are:

	No. 903	No. 921
Aluminum	3.5 -4.5	3.5 -4.5
Copper	0.10 max.	2.5 -3.5
Magnesium	0.03-0.08	0.02-0.12
Iron, max.	0.10	0.10
Lead, max.	0.007	0.01
Cadmium, max.	0.005	0.005
Tin, max.	0.005	0.005
Total other impurities, max.	0.02	0.02
Zinc (Special Grade, High Purity)	Remainder	Remainder

These alloys exhibit a tensile strength of 36,000 and 44,000 pounds per square inch respectively. Compression strength is 60,500 and 93,100; elongation in per cent in two inches is 5.0 and 9.0; brinell hardness is 63 and 80.

Corrosion resistant high purity aluminum-silicon alloys are being studied to round out the scope of the alloys, and this composition has been successfully used in a few small applications. A new alloy containing about five per cent nickel, and having a melting point appreciably higher than alloys hitherto employed, has been developed to meet the requirements of die cast burner heads for certain specific conditions. *Fig.* 6 shows aluminum die castings used in a grease pump where weight is particularly important. Standard SAE aluminum die casting alloys have tensile strengths rang-

Fig. 1—*Top—Brass die castings exactly satisfy aircraft instrument requirements. Fig.* 2—*Top Center—Parts as shown are cast in duplicate for each machine. Fig.* 3—*Bottom Center—Exceedingly light parts of magnesium are possible with die casting process. Fig.* 4—*Bottom—Considerable machining is eliminated by use of zinc alloy die castings*

ng Reach High Plane

ing from 29,000 to 33,000. Elongation is from 1.0 to 4.5 per cent. Standard SAE analyses are:

	No. 304	No. 305	No. 307	No. 309	No. 312
Si	4.5-6.0	11.0-13.0	4.5-5.5	1.0-2.5	1.0-2.0
Cu, max.	0.6	0.6	3.5-4.5	3.5-4.5	7.0-9.0
Fe, max.	2.0	2.0	2.25	2.5	2.5
Zn, max.	0.75	0.75	0.75	0.75	1.0
Mn, max.	0.3	0.3	0.3	0.3	0.3
Mg, max.	0.1	0.1	0.1	0.1	0.1
Ni, max.	0.5	0.5	0.5	3.5-4.5	0.5
Sn, max.	0.1	0.1	0.1	0.1	0.1
Other impurities, Max.	0.2	0.2	0.2	0.2	0.2

The remainder of the composition is aluminum.

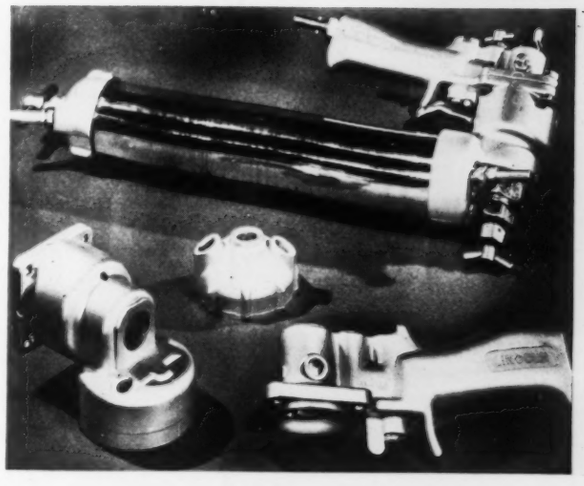
The most common magnesium alloy for die casting purposes has 10.0 aluminum, 0.1 manganese, 0.5 silicon and balance magnesium. This alloy has a tensile strength of 29,000 pounds, elongation of 2 per cent and brinell hardness of from 72 to 81. Typical magnesium die castings are shown in *Fig.* 3.

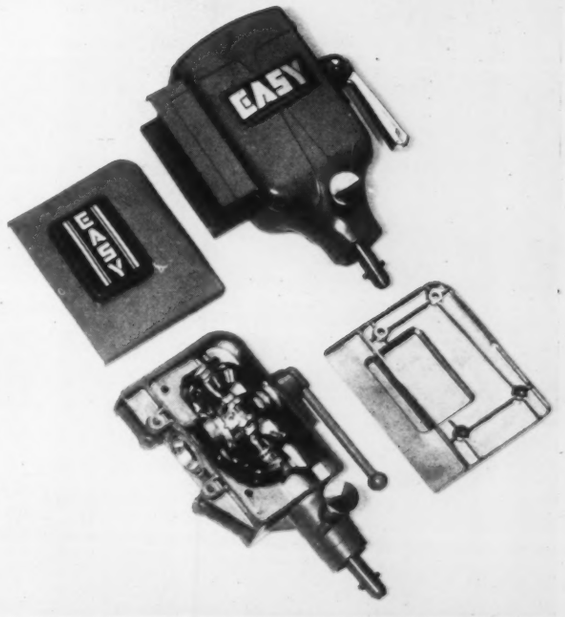
An example of the versatility of the die casting process can be found in the spectacular development of zinc grilles in the automotive industry. These grilles show design ingenuity that could not be utilized by previous methods of fabrication. An outstanding advance in brass die casting is the meter frame and body for an aviation instrument, *Fig.* 1 Aluminum die castings have assumed their place in the designer's considerations by successful application to such machines as the Electromatic typewriter, *Fig.* 8, where light weight and accurate dimensions are requisites, while difficulties of fabrication are eliminated by the die casting of intricate parts.

Encase Die Castings with Plastics

A most interesting recent development in the application of die castings is the encasing of parts made by this process with colorful plastic materials. The use of the plastic over metal enables designers to achieve new beauty and utility in many products where high strength, lustrous color, warmth and smoothness are desired.

Another distinct advance in die castings made during the past year has been in the making of thin wall castings. Thinner sections have been achieved without sacrificing strength—in some cases actually making a stronger part with a thinner section through design ingenuity. This means that on machine parts produced





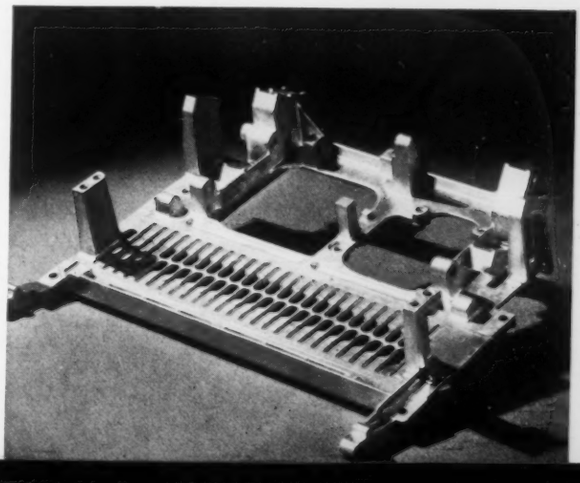


Fig. 5—*Top—Smooth, as-cast surfaces take plating with a minimum of polishing.* *Fig.* 6—*Top Center—Aluminum die castings permit easier handling because of their light weight.* *Fig.* 7—*Bottom Center—Close tolerances were necessary on this part to insure operation.* *Fig.* 8—*Bottom—This complex typewriter part illustrates versatility of the process*

in quantity, a decided economic advantage in metal used is achieved.

Among outstanding new applications must be included a gear housing for a textile machine which weighs over 16 pounds. Some of the automotive grilles weigh as high as 23½ pounds.

In comparison with these large pieces of equipment, the paint spray air gun, *Fig.* 2, is tiny and yet it is assembled almost entirely of zinc alloy die castings. The new alloys furnish the necessary strength for the structural parts and the die casting process furnishes the necessary precision for the valves. Fan blades are die cast integrally with the counter-balanced flywheel. Even the air-intake bells, parts which would at first glance seem to be much more easily fabricated as stampings, were die cast because of the advantage of integrally cast attaching lugs.

A new machine which utilizes die castings to a large degree is the General Electric kitchen waste disposal unit of *Fig.* 9. As many of the parts of this machine are in constant contact with water and food acids, the main bearing, shredder housing and strainer disk are made of aluminum bronze die castings. The housing of the unit, motor coupling, control handle and small parts are zinc alloy die castings.

In the manufacture of a silk creel, smooth surfaces are most important. Rough surfaces or sharp edges will catch too easily and break the fine strands of silk fibers. By die casting the cone holders and tension arms of such a creel, *Fig.* 4, considerable machining is eliminated.

The ease with which complicated parts can be die cast made the valve apparatus for anesthetic gas equipment a practical application for zinc alloy die castings. The smooth, as-cast surfaces, *Fig.* 5, take a bright nickel or chromium plated coating with a minimum of buffing or pretreating. Another part where finish is important is the base and motor support for a meat chopper, *Fig.* 10. When plated, these parts in combination with a molded plastic case have an exceedingly favorably finished appearance.

Evidence of the progress of die castings in design is the fact that a recent survey of electric washing machines brought out that over a third of the parts in almost every type of washer are die cast. Water pump parts including the two-part housing and the impeller are die castings in almost every instance. Agitator support posts, drains, pulleys, levers, caps, and gear cases were also almost universally die cast. The wringer gearcases shown in *Fig.* 7 are an example of washing machine applications. In this instance it was necessary that the parts be cast to required close tolerances in order to insure perfect operation.

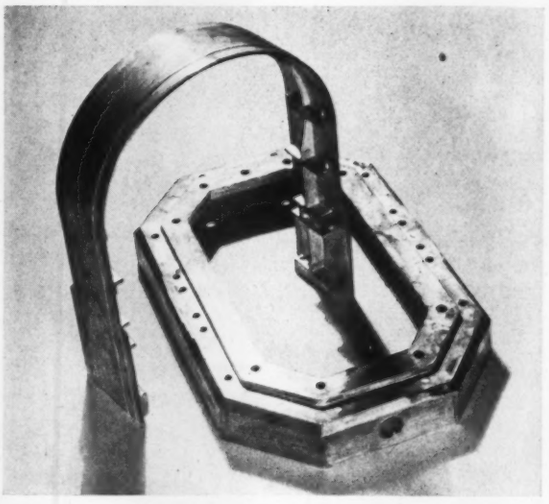


Fig. 10—*Combination of these parts, plated, with plastics, gives pleasing appearance*

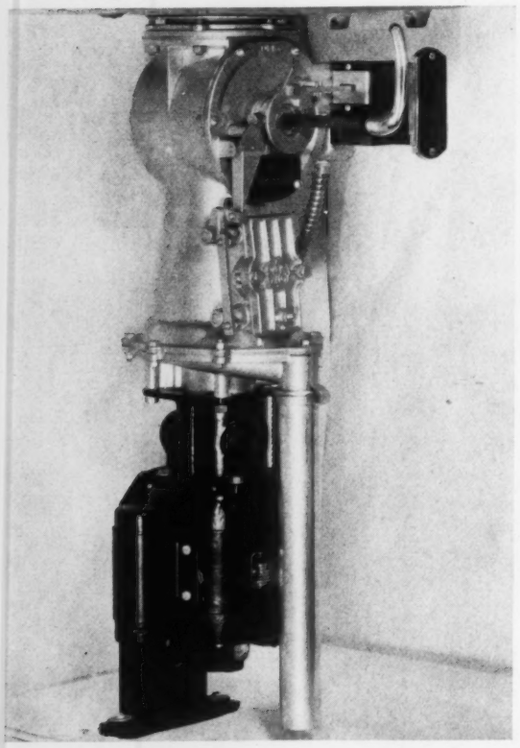
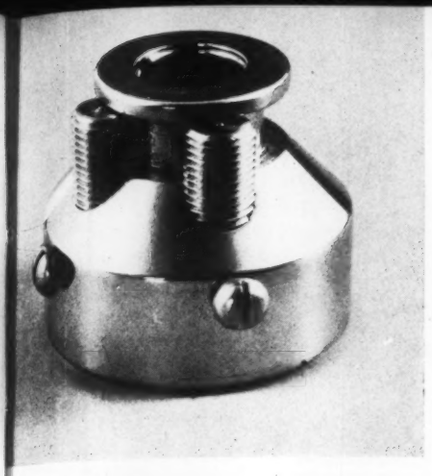


Fig. 9—*Corrosion resistance of die casting alloys benefits this kitchen waste disposal unit*

These few brief applications barely touch on the remarkable advances in die casting utilization made recently in the fields of brass, zinc, aluminum and magnesium. Naturally, like any process, there are limitations and certain fields in which it would be unwise to suggest die castings. But the industry has shown unusual growth and unusual expansion into previously uncharted fields, so the designer will be well advised to check the possibility of utilizing die castings when making his next design.

For their considerate assistance in the preparation of this article, and for the illustrations used, MACHINE DESIGN wishes to thank Aluminum Co. of America, Doehler Die Casting Co., Dow Chemical Co., and the New Jersey Zinc Co.



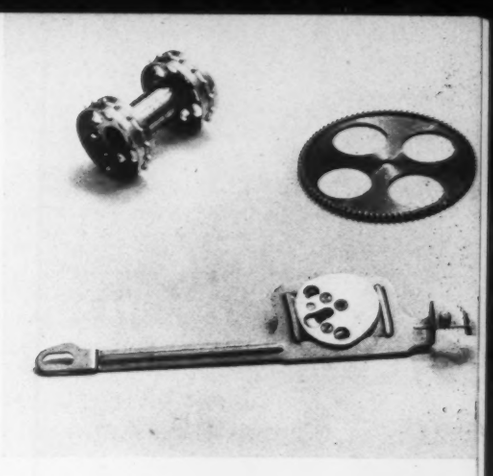


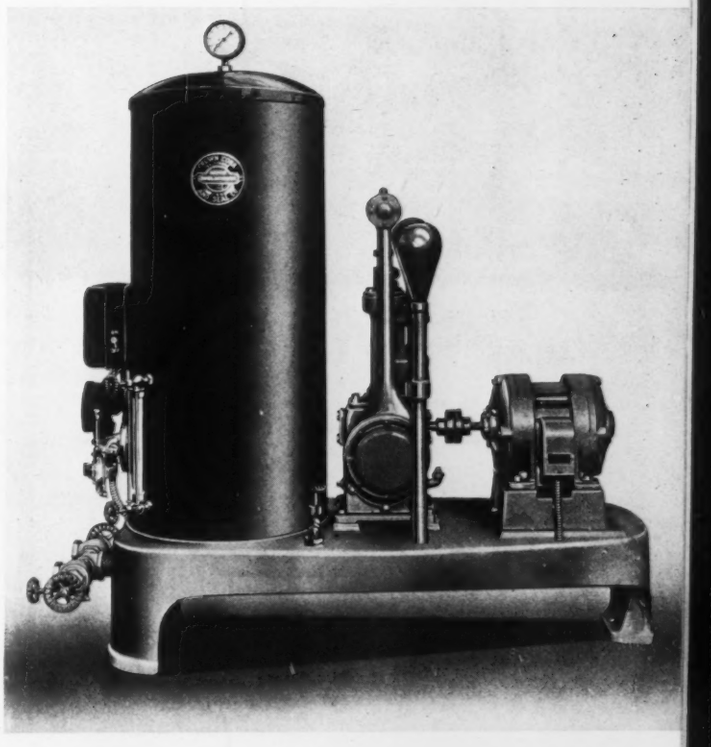
Fig. 1—Left—Machining was considerably simplified on part which employs improved stainless steel. Fig. 2—Right—Extremely close tolerances were maintained on this sprocket wheel made of corrosion resisting material

Design Field Benefits from Stainless Steels

DEVELOPMENT in stainless steels has progressed at such a rapid rate since the introduction of these materials a relatively short time ago, that every designer having a possible application of these steels should check all the various grades carefully to insure the specification of the exactly correct material. Like steels in general, and the alloy steels in particular, the stainless steels are several times as strong and tough as copper and aluminum. Applications, however, lagged because of the time necessary for special tests and experimental work and because of the difficulty encountered in the early days in forming the material.

Makers of these materials have been actively working toward eliminating limitations on the use of stainless steels, especially the fabricating handicap, until today we have approximately fifty commercial alloys designated as stainless steel. Many of these alloys are very simple to fabricate and assemble into machinery. All of these alloys have different physical, mechanical and corrosion resistant properties for special applications.

The development of grades of stainless steels which are easily machinable has, of course, greatly simplified the manufacture of a large number of machined parts, a few of which are shown in the accompanying illustrations. This improved machinability has been



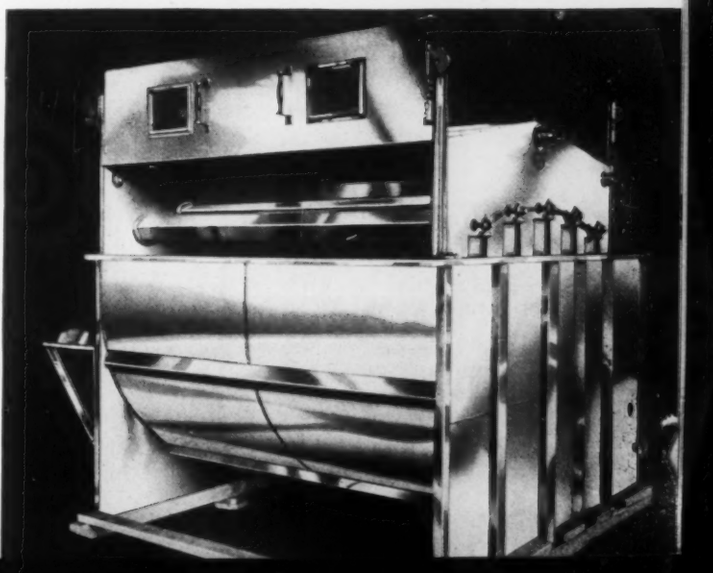


Fig. 3—Above—All parts in contact with carbonated water on this saturator, insulation cover and tank proper are of stainless steel. Fig. 4—Below—Rapid changing of colors in dye kettle is possible because the material used will not retain previous colors. It is imperious to acids

obtained by the addition of various elements, the two which have probably given the most satisfactory results being selenium and sulphur.

Another development which has affected fabrication of various articles is the development of a grade of stainless steel which possesses spinning properties superior to the ordinary grade.

Forging practice as well as manufacturing practice has advanced sufficiently so that it is now possible to obtain the commoner grades of stainless steel with the three desirable characteristics of high corrosion resistance, forgability with a minimum of "hot shortness" and machinability at a profitable and competitive rate of production.

While these materials have been forged

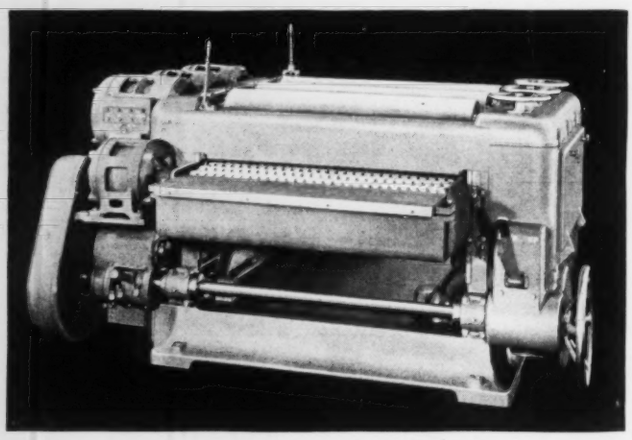


Fig. 4—Corrosion troubles are eliminated in sanders by stainless steel hopper feed plate and by plates of similar material for holding the rubber inserts

readily almost since their inception, lack of machinability has always been a deterrent to wider use of the metals as rolled. Replacement of castings with forgings made from rolled bars is obviously an economy in many applications with not only a saving in time, in materials, and in simplified design, but in improvement in the quality of the product. Stainless castings have been greatly improved and are now available in free-machining types of analyis.

Naturally such advancements, all tending to reduce the difficulty and cost of fabrication, increase the scope of usefulness of stainless steels, not only in totally new fields but also in replacing less economical metals when viewed from the standpoint of dependability, cost of replacement and satisfactory service.

While extruded shapes in the literal sense of the word do not now seem practical, the improvement in rolling practice and finishing operations has made possible products of close tolerance, almost unbelievable finish, and in shapes which at one time were considered well nigh impossible. Manufacturers of cold drawn shapes see no reason why most of the shapes drawn from carbon or alloy steels could not be made in stainless if the requirements called for heat and corrosion resistance. Experience on such shapes to date shows that no particular difficulties are encountered. Stainless steels are regularly drawn in the common shapes such as flats, bars, squares, hexagons, etc. It formerly was common practice until recently to purchase turbine blade stock in bars and machine it to the desired shape and size with considerable loss of material. Lately, however, designers have been able to specify drawn sections to close tolerances and to the finished shape required. Considerable machining time is saved, the loss of material is negligible and the quality of the product is comparable in every detail.

The desirable characteristic of improved machinability of stainless steels in bars has been brought about with very little loss of corrosion resistance due to the addition of foreign elements not normally found in a regular analysis and by the increase in percentage of inherent elements such as sulphur and phosphorus.

Overcomes Welding Difficulty

Through the development of austenitic chrome-nickel stainless steels containing columbium or titanium, a difficulty formerly encountered in welding stainless steels, namely the occurrence of a type of deterioration which developed in zones adjacent to the weld unless they were subjected to heat treatment, has been almost entirely eliminated. The stainless steels containing from six to ten times as much columbium or titanium as carbon are so stable that the deterioration sometimes occurring in the ordinary type does not take place. This same development has made possible the use of these steels at temperatures which cause the ordinary type of stainless to deteriorate rapidly. Other elements which assist this development are molybdenum and titanium.

The versatility of the stainless steels is indicated by the accompanying illustrations. *Fig.* 1 shows a soft-drink dispenser and from its shape designers can realize that considerable machining was necessary. In addition to making this machining possible, the material used gives the part a lasting beauty. It is immune to corrosion of practically all foodstuffs and sterilizing solutions.

Another part which required a great deal of machining is shown in *Fig.* 2. Further, tolerance from point to point of sprocket teeth is only 0.0002-inch plus or minus. The textile industry with its requirements for high corrosion resistance is making extensive use of stainless. The dye kettle shown in *Fig.* 4 is an illustration of this type of application.

For their considerate assistance in the preparation of this article, and for the illustrations used, MACHINE DESIGN wishes to thank: Allegheny Steel Co., Carpenter Steel Co., Electro Metallurgical Co., Republic Steel Corp., and Union Drawn Steel Co.

New Machines Indicate Design Trends

MATERIALS are the backbone of every machine. An ill-advised choice of the substance to be used in a part may easily mean the failure of the entire equipment. Further, advances in research have introduced so many new materials that it is no longer possible to consider only one grouping when making a selection. An indication of how designers are solving this selection problem can be found in every new machine introduced. Valuable aid in making the selection may be obtained from the "Directory of Materials Used in the Design of Machines" on page 43.

Machines recently announced in addition to those on the next two pages include the following, arranged by fields of application:

Air Conditioning

Industrial Equipment, York Ice Machinery Corp., York, Pa.

Bottling

Bottle Cleaning Machine, Karl Kiefer Machine Co., Cincinnati.

Construction

Rock Crusher, Nordberg Mfg. Co., Milwaukee.

Domestic

Vacuum Cleaners, P. A. Geier Co., Cleveland.

Ironers, Norge Corp., Detroit.

Washing Machines, Hurley Machine Co., Chicago.

Stokers, Link-Belt Co., Chicago.

Washing Machines, Norge Corp., Detroit.

Food

Liquid Meter, Pittsburgh Equitable Meter Co., Pittsburgh.

Bag Filling Machine, Cartoning Machinery Corp., Providence, R. I.

Industrial

Floor Cleaning Machine, Fay Co., New York.

Electric Hoist, Harnischfeger Corp., Milwaukee.

Pipe Machine, Beaver Pipe Tools Inc., Warren, O.

Rotary Displacement Meter, Roots-Connersville Blower Corp., Connersville, Ind.

Marine

Supercharged Engine, Graham-Paige Motors Corp., Detroit.

Six-Cylinder Diesel Engine, Kermath Mfg. Co., Detroit.

Horizontal Double-Opposed Type Diesel Engine, Covic Diesel Engine Co., Los Angeles.

Lighting Plant for Small Boats, Pioneer Gen-E-Motor Corp., Chicago.

Metalworking

Cutting Off Machine, Modern Machine Tool Co., Jackson, Mich.

Horizontal Opposed Hydraulic Feed Milling Machine, Defiance Machine Works, Defiance, O.

Flexible Shaft Grinder, Stanley Electric Tool division, Stanley Works, New Britain, Conn.

Milling Machine, U. S. Tool Co., Inc., Ampere, N. J.

Inclinable Press, Niagara Machine & Tool Works, Buffalo.

Automatic Straightening and Polishing Machine, Medart Co., St. Louis.

Packaging

Can Packing Machine, J. L. Ferguson Co., Joliet, Ill.

Painting

Paint Circulating Equipment, Binks Mfg. Co., Chicago.

Power

Underfeed Stoker, Whiting Corp., Harvey, Ill.

Steam Return System, American District Steam Co., North Tonawanda, N. Y.

Rubber

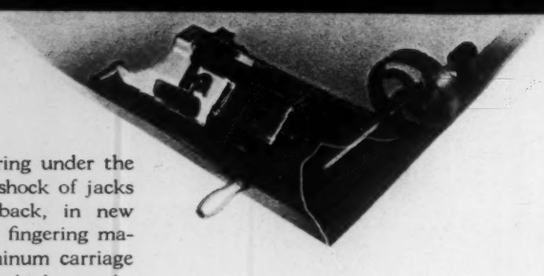
Variable Planetary Cabling Machine, New England Butt Co., Providence, R. I.

Laboratory Mills, William R. Thropp & Sons Co., Trenton, N. J.

Textile

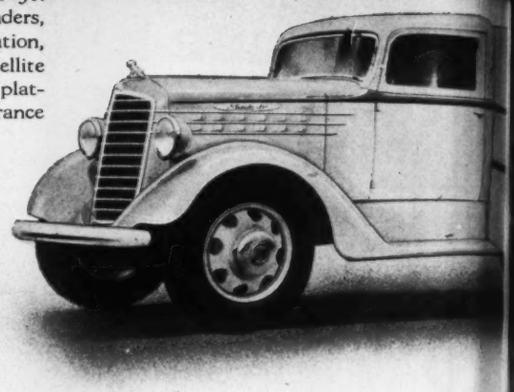
Automatic Single Pick Looms, William H. Baker, Boston.

High Speed Warp Knitting Machine, Collins Loom Works Inc., Amsterdam, N. Y.



special coil spring under the
:d absorbs the shock of jacks
hen dropping back, in new
amb high speed fingering ma-
ıine. The aluminum carriage
ds in achieving high speeds.

Engine on new Mack Jr. truck has alloy iron cylinders, full pressure lubrication, aluminum pistons and Stellite valve inserts. Chrome plating features the appearance of the line.



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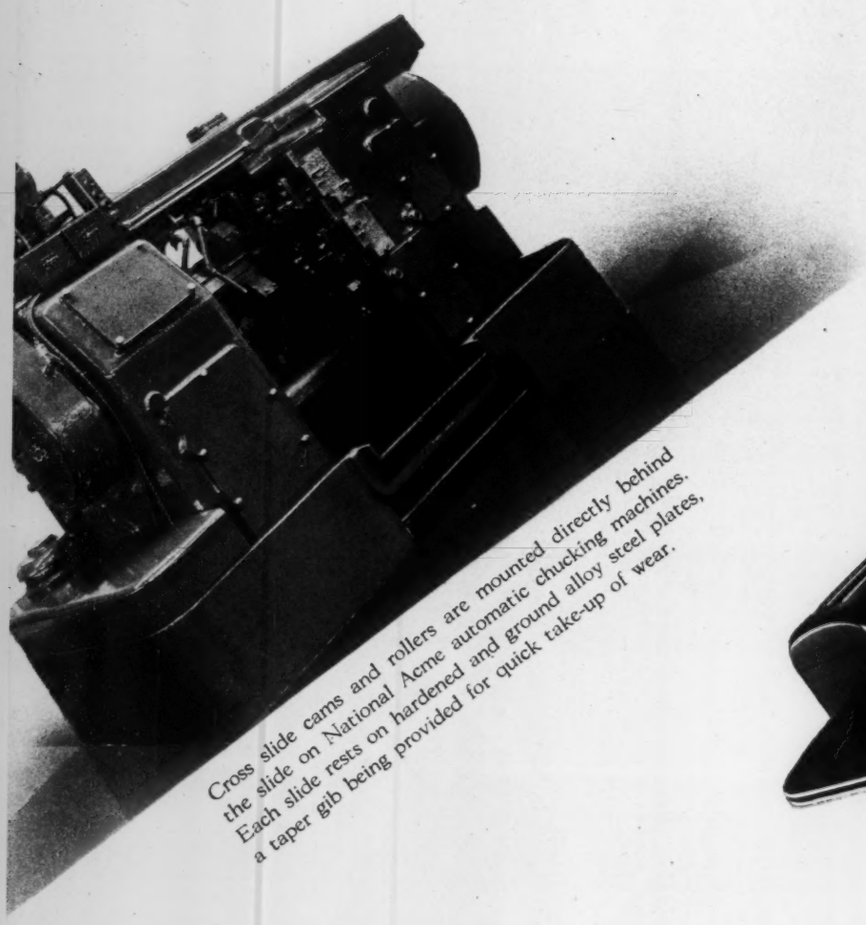
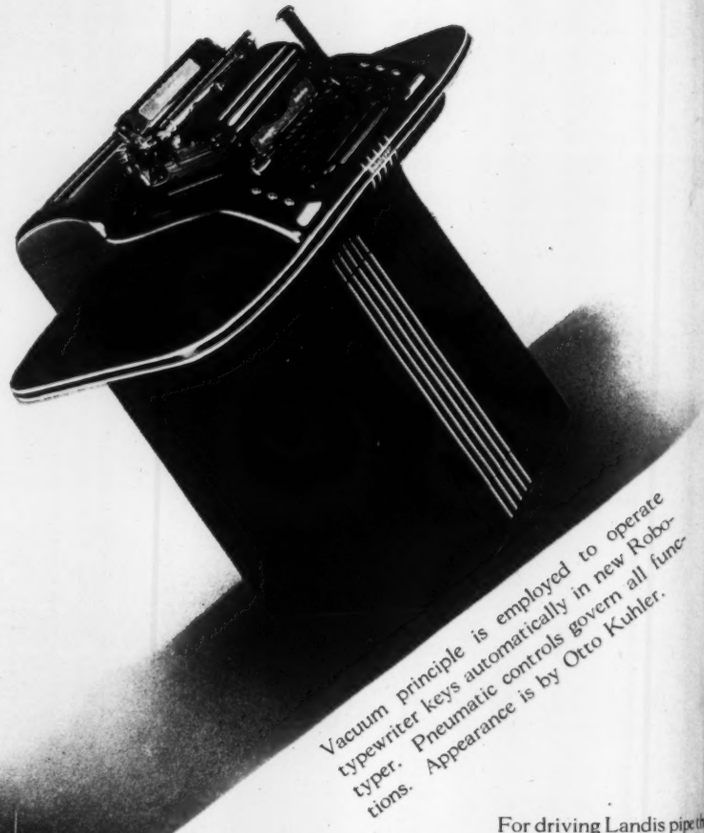
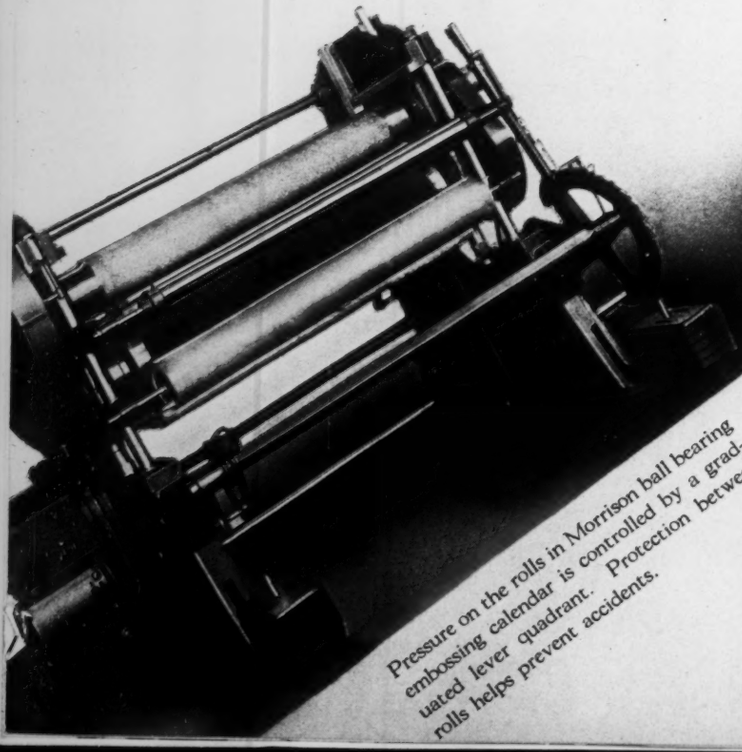


Cross slide cams and rollers are mounted directly behind the slide on National Acme automatic chucking machines. Each slide rests on hardened and ground alloy steel plates, a taper gib being provided for quick take-up of wear.

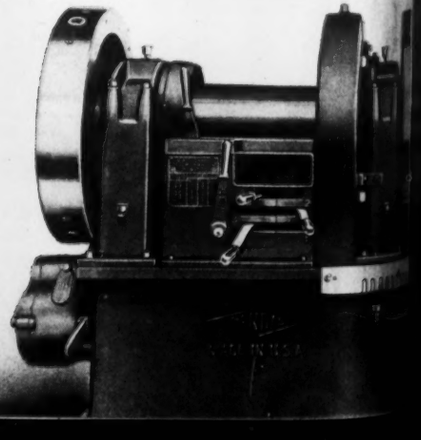


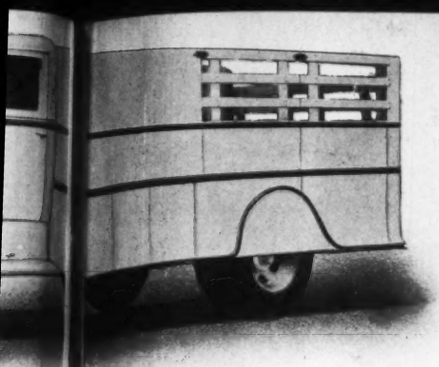
Vacuum principle is employed to operate typewriter keys automatically in new Robotyper. Pneumatic controls govern all functions. Appearance is by Otto Kuhler.

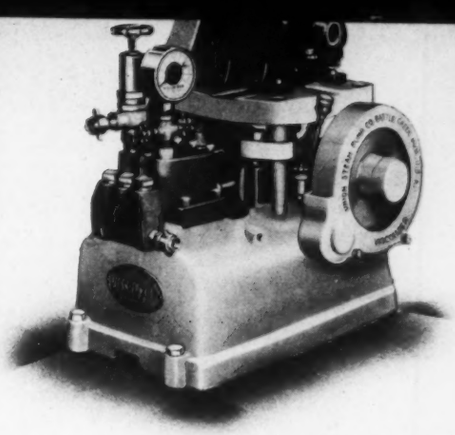


Pressure on the rolls in Morrison ball bearing embossing calendar is controlled by a graduated lever quadrant. Protection between rolls helps prevent accidents.

For driving Landis pipe thre
at threading speeds a fric
used, whereas a tooth clut
for slow speeds. Separate
through each clutch.



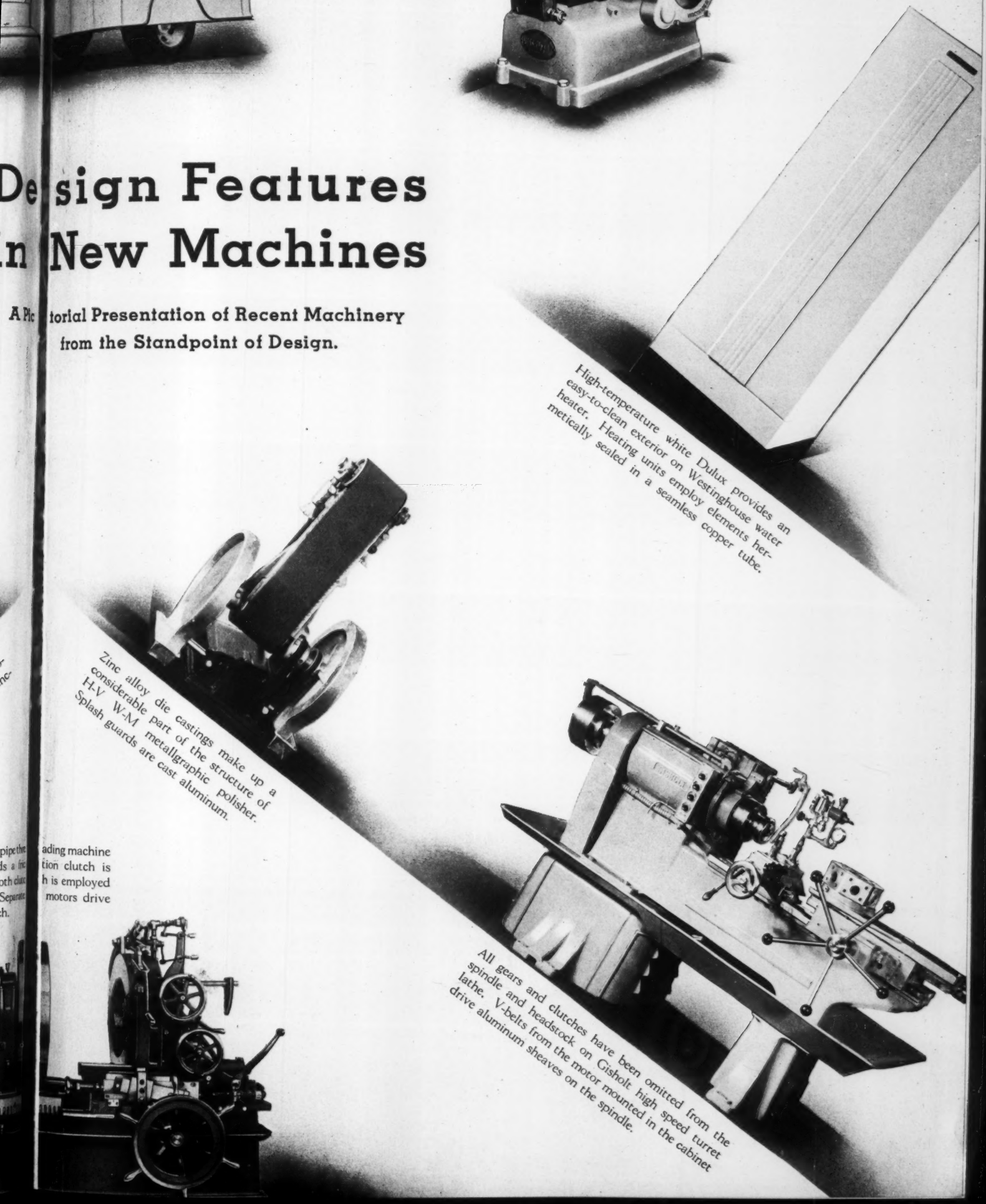




Laboratory model viscolizer of Cherry-Burrell is driven by silent chain. All parts coming in contact with the product processed are made of non-corrosive hydraulic bronze. Plug and seat of regulating valve are Stellite.

De sign Features
n New Machines

A Pic torial Presentation of Recent Machinery from the Standpoint of Design.



High-temperature white Dulux provides an easy-to-clean exterior on Westinghouse water heater. Heating units employ elements hermetically sealed in a seamless copper tube.

Zinc alloy die castings make up a considerable part of the structure of H-V W-M metallgraphic polisher. Splash guards are cast aluminum.

All gears and clutches have been omitted from the spindle and headstock on Gisholt high speed turret lathe. V-belts from the motor mounted in the cabinet drive aluminum sheaves on the spindle.

ading machine
tion clutch is
h is employed
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DESIGN

Flow of New Engineering Materials Keeps Designers on Toes

EVEN as this issue goes to press, further new developments are coming to light in alloys, in heat treatment of metals, and in application of nonmetallics in machinery. But of one thing we are sure —the directory appearing on the center pages of this issue of MACHINE DESIGN contains the most authentic and up-to-date data on engineering materials as used in machines. The same may be said of the editorial articles in the balance of the issue.

Perusal of these contents will immediately disclose the increased consideration being given to at least three types of alloys. First come the lightweight alloys; second, the stainless group; and third, the low-alloy, high tensile steels. Such interest can have but one result—a general reduction in weight of machine parts and complete units. This is obvious in the case of the lighter metals, and also is evident in regard to the two steels mentioned, in view of the strength-weight ratio of the one and the corrosion resistance of the other.

Chief engineers and designers have many tasks besides choice of materials, yet this problem is being recognized as one of primary importance. Constant increase in number of alloys is tending all the time to make the job of selection more confusing, yet the fact remains that the choice *is* widening—and bringing with it sheer necessity for the designer to keep himself abreast of the ever-recurring changes.

Will Machines Be Taxed?

PROPONENTS of the measure whereby new machinery would be taxed to provide relief for workers whom the machines are supposed to displace should consider this proposal from every angle before jumping to conclusions. Many factors that would nullify the success of such a project might be cited. One of the foremost of these is that if the creation of new machinery is retarded for this or any other reason in this country, other nations will quickly take the lead and we will find ourselves much worse off in the long run.

Such proposals smack of earlier endeavors, on the part of workmen, union leaders and others, to hinder the development of new machines. And history records, in all these cases, the negative boomerang effect resulting from the measures taken. Let us accept the lesson and if higher taxes must be levied, put them on the increased incomes derived as a result of the higher speeds of machine production.

Editorial

Fourth edition of Machine Design's Directory of Materials covering Iron, Steel and Non-ferrous Alloys, Plastics and other Non-metallics.

BECAUSE of the growing importance of plastics and other nonmetallic materials in the design of machinery, this fourth edition of MACHINE DESIGN'S directory includes the listing of these products marketed under tradenames. The new nonmetallics section of the directory commences on page 67-25D.

AS in the previous edition of the directory, numerals have been used to classify the properties of the alloys and the specially processed irons and steels included in the alloy section. When numerals appear on the line immediately above the tradename only, all types or grades produced under that tradename possess the properties designated by the numerals. Where properties vary with the grades, identifying numerals are shown above those grades, and if the properties exceed three in number the additional properties are mentioned in the text. Key to the numerals appears at the foot of each page.

TO extend the utility of the directory in the engineering department it has been bound so that it may be removed by unstapling, without damage to either the magazine or the directory. Separate additional copies of the directory also are available in reprint form at 25 cents per copy.

Iron, Steel and Nonferrous Alloys

A

1 - 3 4 - - - - - -

ABRASOWELD—Lincoln Electric Co., Dept. MD., Coit Rd., Cleveland. Arc welding electrode for providing abrasion resisting, self-hardening alloy deposit which hardens rapidly under impact and abrasion; moderate peening increases hardness from 20-30 Rockwell C to 50 Rockwell C; maximum hardness developed at surface, leaving cushion of softer metal beneath; will not check or flake; can be forged hot; provides resistance to severe abrasion in straight carbon steel, low alloy or high manganese steel surfaces; effective on gear and pinion teeth.

1 2 3 4 - - - - - -

ACME—Acme Steel Co., 2840 Archer Ave., Chicago. Stainless strip steel.

1 2 3 - - - - - - -

Type 410; chromium 12 to 14, carbon .12 max., silicon .5, manganese .5, phosphorus and sulphur .025.

Type 425; chromium 14 to 16, balance of analysis same as above.

Type 430; chromium 16 to 18, balance of analysis same as Type 410.

1 - 3 4 - - - - - -

Type 302; chromium 17 to 19, nickel 7 to 9, carbon .08 to .20, balance same as Type 410.

Type 304; chromium 17 to 19, nickel 7 to 9, carbon .11 max., balance of analysis same as Type 410.

- - 3 - - - - - - -

ADAMANTINE—Babcock & Wilcox., 85 Liberty St., New York. Special steel castings with wear-resisting qualities and machinable surfaces; for grinding mills, mixers, conveyers, power shovels.

- - 3 4 - - - - - -

ADAMITE—Mackintosh-Hemphill Co., Pittsburgh. Alloy steel characterized by strength plus wear resistance.

1 - 3 - 5 - - - - -

ADMIRALTY BRONZE—Chase Brass & Copper Co. Inc., Waterbury, Conn, and Scovill Mfg. Co., Waterbury, Conn. Copper 70, tin 1, zinc 29; standard alloy for condenser tubes, particularly for salt or brackish water.

1 2 - 4 - - - - - -

ADNIC—Scovill Mfg. Co., Waterbury, Conn. Copper 70, tin 1, nickel 29; tubing, rod, wire and sheet.

- - - - - - - 7 - -

ADVANCE—Driver-Harris Co., Harrison, N. J. Copper 54, nickel 46; thermocouple material for application where low temperature coefficient of resistivity is required; also for measuring instruments, industrial and radio rheostats and elevator controls.

- - - 4 5 - - - - -

AGATHON—Alloy Steel Div., Republic Steel Corp., Massillon, O. These alloy steels meet demands for material of lighter weight, greater strength, resistance to shock, impact and torsional strain, and high fatigue resistance; for severe service.

1 - - - - - - 7 - 9

ALCOA—Aluminum Co. of America, 634 Gulf Bldg., Pittsburgh. Aluminum alloys for sand, die and permanent mold castings; also available in form of plate, sheet, foil, bars, rods, wire, tubing, moldings, structural shapes, forgings, screw machine products, rivets, and stampings; grades with varying compositions to meet specific requirements.

1 - - - - - - 7 - -

ALCUMITE—Duriron Co. Inc., Dayton, O. Copper 90, aluminum 9, iron 1; for pumps, valves, pipe, fittings, bars and castings for corrosive service where a copper base alloy is preferred.

1 2 - 4 - - - - - -

ALCUNIC—Scovill Mfg. Co., Waterbury, Conn. A nonferrous alloy in tubing, rod, wire and strip form.

- - - - - - 6 - - -

ALLAN RED METAL—A. Allan & Son, 601 Bergen St., Harrison, N. J. copper lead-bearing alloys; segment castings for facing pistons; bearings for turbines, centrifugal pumps, high speed grinders, etc.

1 2 - - 5 - - - - -

ALLEGHENY—Allegheny Steel Co., Brackenridge, Pa.

1 - - - - - - - - -

Metal, grade C; carbon .08 to .20, phosphorus max. .025, sulphur max. .025, silicon max. .50, manganese max. .50, chromium 17 to 19, nickel 7 to 9; for dairy equipment, food processing equipment, automobile and building trim, chemical plant, household and kitchen accessories.

1 2 - - - - - - - -

33; carbon max. .12, manganese max. .50, phosphorus max. .025, sulphur max. .025, silicon max. .50, chromium 12 to 14; resists temperatures up to 1500 degrees Fahr.; for automotive parts, combustion and steam engine parts, chemical plant equipment, tanks, fans, blowers and furnace parts.

- 2 - - 5 - - - - -

44; carbon .20 max., manganese 1.25 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 22 to 26, nickel 11.0 to 13; resists scaling at temperatures up to 2000 degrees Fahr.; malleable and ductile; used for furnace parts, industrial ovens, kiln linings, still tube supports.

1 2 - - - - - - - -

46; carbon .10 max., manganese .50 max., phosphorus .04 max., sulphur .04 max., silicon .50 max., chromium 4 to 6; following elements may be added for increased resistance to oxidation and for improved mechanical properties: Molybdenum .40 to .60, tungsten .75 to 1.25, copper .50 to 1; for non-hardening characteristics aluminum .10 to .25, titanium or columbium ten times carbon per cent; adaptable for wide range of uses in the oil industry.

- 2 - - - - - - - -

55; carbon .25 max., manganese 1.00 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 23 to 30; for high temperature service up to 2150 degrees Fahr.; used for furnace parts, boiler baffles, kiln lining, glass molds, oil still tube supports, etc.

1 - - - - - - - - -

66, carbon max. .12, manganese max. .50, phosphorus max. .025, sulphur max. .025, silicon max. .50, chromium 16 to 18; resists oxidation to temperatures up to 1600 degrees Fahr.; used for steel engine parts, low temperature furnace parts, fans and blowers, evaporators and chemical plant equipment.

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

- - - - - - - 7 - -

ALNICO—General Electric Co., Schenectady, N. Y., and Simonds Saw & Steel Co., Lockport, N. Y. Permanent magnet alloy of high coercive force; nickel 20 to 30 per cent, aluminum 10 to 12, cobalt 3 to 5, balance iron; extremely hard and obtainable in cast form.

1 2 - 4 - - - - -

AMBRAC—American Brass Co., Waterbury, Conn. Grade A; copper 75, zinc 5, nickel 20; used for condenser tubes, etc.

- 2 - - - - - - -

AMBRALOY—American Brass Co., Waterbury, Conn. Aluminum bronze alloys for varied special uses.

1 2 3 - - - - - -

AMERICAN—American Stainless Steel Co., Commonwealth Bldg., Pittsburgh.

Stainless steel; chromium 8 to 60, carbon over .12, balance mostly iron; for oil, textile, pumping machinery, and other equipment requiring a corrosion resistant, tough, hard, high strength, heat treated alloy.

Stainless iron; chromium 8 to 60; carbon .12 or under, balance mostly iron; for oil, dairy, laundry, textile, paper, refrigerating equipment, etc.

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AMPCO METAL—Ampco Metal Inc., 3830 West Burnham St., Milwaukee.

Grade 16; copper 86.25, aluminum 10.35, iron 3.40; brinell 150; for bushings, gears, etc.

Grade 18; copper 84.80, aluminum 11.40, iron 3.80; brinell 175; for acid equipment, gears, worm wheels, welding jaws, etc.

Grade 20; copper 83.33, aluminum 12.50, iron 4.17; brinell 235; for cams, rollers, hard bushings, safety tools, etc.

Grade 21; copper 82.54, aluminum 13.16, iron 3.30; brinell 295; for form and draw dies, bushings on nitrided shafts, etc.

Grade 22; copper 81.87, aluminum, 13.62, iron 4.51; brinell 330; for drawing dies.

For further information see ad on page 72—30 D.

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AMSCO—American Manganese Steel Co. Inc., Chicago Heights, Ill.

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Manganese steel; 12 to 13 manganese, 1.10 to 1.20 carbon, balance iron; for power shovel dippers and teeth, rock crusher parts, dredge pumps, oil rig sheaves, etc.

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Alloy F-1; 14 to 17 chromium, 34 to 37 nickel; for conveyor chain, enameling furnace supports, burner parts, etc.; heat resistant up to 2000 degrees Fahr.

F-3; 26 to 29 chromium, 0 to 3 per cent nickel; for rabble arms and blades, sintering bars, etc.; heat resistant up to 1800 degrees Fahr. where temperature changes are not wide and where high unit strength is not essential.

F-5; 16 to 19 chromium, 65 to 68 nickel; furnace conveyor pans, heat treating boxes, enameling fixtures, etc.; similar properties to F-1 and F-6, except tougher and more resistant to temperature fluctuations.

F-6; 11 to 14 chromium, 59 to 62 nickel; for heat treating boxes, etc.

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F-8; 17 to 20 chromium, 7 to 10 nickel; for mine water and acid pump parts, marine fittings, chemical mixer and paper mill digester parts.

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F-10; 23 to 28 chromium, 10 to 13 nickel; for heat treating furnace shafts, dampers and valves, cement kiln cooler parts, etc.

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Nickel-manganese steel; 13 to 15 manganese, .75 to .95 carbon, .90 to 1.20 silicon, 3.50 to 4.50 nickel; welding rod for building up austenitic manganese steel castings.

No. 459; welding rod for hard surfacing machinery wearing parts; deposits are 500 to 600 brinell.

No. 217; welding rod for hard facing cast wearing parts; extreme hardness and great wear resistance.

1 2 - 4 - 6 7 - -

ANACONDA — American Brass Co., Waterbury, Conn.

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Beryllium Copper; copper 97.75, beryllium 2.25, nickel .25; for springs, diaphragms, low duty bushings and bearings.

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"85" Red Brass; copper 85, zinc 15; pipe, tube and sheet forms; particularly resistant to salt water corrosion.

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Super-Nickel; copper 70, nickel 30; seamless tubes, sheets and plates; for severe condenser tube service and resistance to salt water corrosion.

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Special Phosphor Bronze; copper 88, tin 4, zinc 4, lead 4; combines general characteristics of standard phosphor bronze alloys with free cutting qualities of yellow brass.

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ANFRILOY—Wellman Bronze & Aluminum Co., 6017 Superior Ave., Cleveland. Antifriction bearing bronze for high speed, light duty bearings and for bushings where pressure and thrust are not excessive; a copper, lead, tin alloy No. 6.

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APEX—Apex Smelting Co., 2554 Fillmore St., Chicago. A series of zinc base die cast alloys.

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APOLLOY METAL—Apollo Steel Co., Apollo, Pa. Carbon .08, manganese .40, sulphur .025, phosphorus under .045, copper .25 per cent; in sheets.

1 2 3 4 5 - 7 - -

ARMCO—American Rolling Mill Co., Middletown, O.

1 2 - 4 - - - - -

Grade 16-6 (type 301, 301S); 18-8 (type 302, 304); 19-9 (type 305, 306); 20-10 (type 307, 308); 25-12 (type 309); 17 (type 430) RA (type 434A); 15 (type 425).

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Armco H.T.-50; high tensile steel.

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Tran-Cor 60; high silicon steel for distribution transformers. Grade 66; steel sheets with low core loss, for power and distribution transformers. Grade 72; a high silicon steel for large generators and general transformer work.

Intermediate Transformer; scale-free silicon steel sheet for some transformer and special applications.

Special Electric; scale-free medium steel sheet for a.c. motors and generators.

Electric; special analysis sheet for rotating machines.

Armature; steel sheet for small d.c. motors.

Field Grade; special sheet for intermittent duty fractional horsepower motors.

Radio No. 6; for applications in which superior low induction magnetic characteristics are important. No. 5; for audio transformer cores and other low induction applications. No. 4; good permeability at low induction; for chokes. Nos. 3, 2 and 1; for small transformers.

Ingot Iron; highly refined iron for magnetic cores; supplied in round and flat bar form.

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Armco Ingot Iron; highly refined iron supplied in galvanized sheet for general sheet metal work; also hot rolled annealed and cold rolled sheets, plates and strip.

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Armco Enameling Iron; highly refined iron for enameling purposes; supplied in sheets.

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AR STEEL—Carnegie-Illinois Steel Corp., Carnegie Bldg., Pittsburgh. Carbon .35 to .50, manganese 1.50 to 2, phosphorus .05 max., sulphur .055 max., silicon .15 to .30, copper .20 min. if desired; for fan blades, chute linings, conveyor troughs, wearing plates, etc.

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ASARCOLOY No. 7—American Smelting & Refining Co., Equitable Bldg., New York. A cadmium-nickel bearing alloy capable of withstanding high compression loads and high operating temperatures.

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ATLAS—Ludlum Steel Co., Watervliet, N. Y. No. 93; chromium .65, molybdenum .35; for collets, studs and parts requiring toughness in hardened condition.

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AUROMET—Aurora Metal Co., 614 W. Park Ave., Aurora, Ill. Special aluminum bronzes of several compositions.

- 2 - - - - - - - 9

AVIALITE — American Brass Co., Waterbury, Conn. Copper-aluminum alloy for valve seats and guides in airplane motors.

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

1 - 3 4 - - - - - -

A.W.—Alan Wood Steel Co., Conshohocken, Pa.

- - - 4 - - - - -

70-90 Type A; high strength steel; furnished in sheets and plates; excellent weldability.

Type B; properties similar to above material.

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Abrasion resisting steel; carbon-manganese-silicon alloy; furnished in sheets and plates.

B

1 2 - - - - - - - -

B & W ALLOY 2; Babcock & Wilcox Tube Co., Beaver Falls, Pa. carbon .15 max., chromium 1.75 to 2.25, molybdenum .40 to .60, silicon .50 max.; for refinery and superheater tubes.

ALLOY 5; chromium molybdenum; 4 to 6 per cent chromium for oil refinery service.

ALLOY 9; carbon .15, max., chromium 8 to 10, molybdenum 1.25 to 1.75; semi-stainless alloy of good physical properties.

ALLOY 18-8; low carbon; for high temperature work if no long heating is involved.

ALLOY 18-8; general purpose alloy similar to Alloy 18-8 low carbon except that for pressure service the temperature should not exceed 600 degrees Fahr.

ALLOY 25-20; chromium 25, nickel 20; has high strength and high oxidation resistance, also excellent corrosion resistance.

1 2 - - - - - 7 - -

BAKER—Baker & Co. Inc., 60 Austin St., Newark, N. J. Platinum and alloys for linings, contacts, thermocouples, furnace resistors, etc.

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BARBERITE—Barber Asphalt Co., Ins. Co. N. A. Bldg., Philadelphia. 88.5 per cent copper, 5 nickel, 5 tin and 1.5 silicon; for applications where dilute sulphuric acid concentrations are below 60 degrees Be' and temperature below 96 degrees Cent.

- - - - - 6 - - -

BEARIUM METAL—Bearium Metals Corp., 258 State St., Rochester, N. Y. Non-scoring, non-seizing bronze bearing metal supplied in several grades and analyses to meet specific operating conditions; composed of copper, tin, and lead, combined by special process.

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BETHADOUR—Bethlehem Steel Co., Bethlehem, Pa. Steels of the designated charactertistics for virtually all purposes except those calling for free machining.

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BETHALON — Bethlehem Steel Co., Bethlehem, Pa. Free machining high chromium steel for variety of machine parts.

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BIRDSBORO—Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

No. 26; high physical properties including high tensile strength.

No. 30; corrosion and fatigue resisting.

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BLACKOR—Blackor Co., 13007 S. Main St., Los Angeles, Calif. Tungsten carbide specially processed for electric arc welding application in grading and agricultural machinery, coal mining equipment, for airplane skid shoes and other uses where resistance to abrasion is primary consideration.

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BOHNALITE — Bohn Aluminum & Brass Corp., 2515 E. Grand Blvd., Detroit. Light alloy of which aluminum is the base; for forged connecting rods, cast cylinder heads, crankcases, transmission cases, and parts for vacuum cleaners, washing machines, shoe machinery, etc.

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BONNEY-FLOYD—Bonney-Floyd Co., Marion Rd., Columbus, O.

MM; manganese, molybdenum and .25 to .35 carbon; high physical properties for general purposes.

NCM; nickel, chrome, molybdenum, carbon .25 to .35; for bucket lips, bucket teeth, dragline clevises and other uses where abrasion is encountered.

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BORIUM—Stoody Co., Whittier, Calif. Tungsten carbide metal used as inserts in oil well and water well rotary drilling tools as substitute for diamonds.

Tube Borium and Borod; made up of steel tubing containing fine particles of Borium; used as overlays on earth digging, moving and earth boring equipment.

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BOUND BROOK—Bound Brook Oilless Bearing Co., Bound Brook, N. J. Graphite and bronze bushings, bearings and washers.

1 - - 4 5 - - - -

BRASTIL—Doehler Die Casting Co., 386 Fourth Ave., New York. Copper base alloy containing more than 81 per cent copper; has high strength and hardness, high resistance to fatigue, shock and corrosion, with good bearing qualities; for die cast parts.

BRUNELLA E-1 — Niagara Falls Smelting & Refining Corp., Buffalo. Anti-piping powder for gray iron and steel that contains no carbon or metallic silicon.

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BUNTING—Bunting Brass & Bronze Co., Spencer & Carlton Sts., Toledo. A line of some 160 bearing bronzes including the following:

Low lead bronze alloys:

Alloy No. 27; copper 80, tin 10, lead 10.

Alloy No. 72; copper 83, tin 7, lead 7, zinc 3.

Alloy No. 124; copper 85, tin 5, lead 9, zinc 1.

Medium to high lead bronze alloys:

Alloy No. 125; copper 75, tin 5, lead 20.

Alloy No. 135; copper 77, tin 8, lead 15.

Alloy No. 158; copper 70, tin 5, lead 25.

Alloy No. 161; copper 63, tin 2, lead 35.

Alloy No. 162; copper 70, tin 9, lead 21.

Hard phosphor bronzes:

Alloy No. 51; copper 86.5, tin 10, lead 1.5, zinc 2.

Alloy No. 96; copper 87, tin 10, lead 3.

Alloy No. 98; copper 88, tin 10, zinc 2.

Alloy No. 156; copper 90, tin 10.

Alloy No. 164; copper 87, tin 11, lead 1, nickel 1.

Babbitts:

Alloy 116; copper 6, tin 87, antimony 7.

Alloy No. 170; tin 10, lead 75, antimony 15.

For further information see ad on page 70-28D.

C

1 2 - 4 - - - - - -

CALITE—The Calorizing Co., Wilkinsburg Station, Pittsburgh.

Type A; nickel-chromium-iron alloy available in the form of castings and rolled bar stock; readily machinable.

Type B; cast form only for oil refining industry.

Type B-28; available as castings, sheet and bar stock; possesses extreme stiffness at all temperatures and is corrosion resistant.

Type N; nickel-chromium-iron in sheets, bars, castings.

Type S; malleable alloy steel; greatest utility in form of hot rolled sheets for corrosion work at moderate temperatures; may be flanged, punched or assembled by welding.

Type E; a malleable alloy steel in form of bars and sheets; not affected by weather corrosion, sulphur compounds and many organic acids and inorganic salts.

Calite-Nirosta stainless steels in cast form.

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CALSUN BRONZE — American Brass Co., Waterbury, Conn. Copper 95.50, aluminum 2.50, tin 2. A wire alloy used for structural strength.

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CANNONITE — Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich. Electric furnace high test cast iron; total carbon 2.75 to 3; for diesel and auto cylinders, centrifugal sleeves and brake drums, gas-tight castings, presses, dies, etc.

1 - 3 - - - - - - -

CARBOLOY—Carboloy Co. Inc., 2977 E. Jefferson Ave., Detroit. A cemented carbide that has high resistance to abrasive and corrosive

wear; rockwells as high as 97.5 on the A scale; for wear resistant inserts to impart longer life to parts such as cams, cam followers, hydraulic valve stems and seats, machine tool rests, etc.

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CARBOMANG—Detroit Alloy Steel Co., 6500 Wight St., Detroit. Carbon .9 to 1; manganese 1 to 1.10, chromium .40 to .60; oil hardening tool steel castings.

1 2 3 4 5 6 7 - -

CARPENTER — The Carpenter Steel Co., Reading, Pa.

1 2 - 4 - - - - -

No. 1 stainless bar steel; carbon .10, chromium 11.5 to 13; for valve trim, turbine blades, pump shafts and many heat treated parts.

1 2 - - 5 - - - -

No. D-1 stainless strip and wire; carbon .10, chromium 15 to 16; for stampings, moldings, cold headed screws, rivets, etc.

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No. 2; carbon .3, chromium 13; used in fully hardened conditioned for ball bearings, ball check valves, etc.

No. 2B; carbon 1.00, chromium 17; uses same as No. 2.

1 2 - - - - - - -

No. 3; carbon .3, chromium 20, copper 1; for special chemical apparatus and scale resisting parts.

1 2 - 4 - - - - -

No. 4; carbon .10, chromium 18, nickel 9; for rolled moldings, stampings, etc.; also has high ductility.

1 2 3 - - - - - -

No. 5; carbon .10, chromium 14, sulphur .30; a free machining grade.

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No. 6; carbon .10, chromium 17; uses same as No. D-1 and No. 4.

1 2 3 - - - - - -

No. 8; carbon .10, chromium 18, nickel 9, selenium .25; a free machining grade.

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No. 5-317; chrome nickel steel; carbon .50, nickel 1.75, chromium 1; for gears, clutches and shafts.

No. 4-408; carbon .40, nickel 3, chromium .75; for clutches and shafts.

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No. 158; carbon .10, nickel 3.50, chromium 1.50; for case hardened high duty clash gears, shafts, clutch parts.

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No. 4 Samson steel; carbon .40, nickel 1.25, chromium .60; for side links of silent chains, etc.

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No. 2 Samson; carbon .20, nickel 1.25, chromium .60; for gears, roller bearings, pneumatic tool parts, etc.

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N-30; 30 per cent nickel; nonmagnetic, for electrical parts requiring special thermal expansion properties.

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No. 3-547; nickel steel; carbon .30, nickel 3.50; for heat treated shafts, etc.

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No. 2-547; case hardening nickel steel; carbon .20, nickel 3.50; for small parts requiring hard surface and tough core.

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No. 500; carbon .10, nickel 5; for turbine blades, case hardened gears, etc.

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Chrome magnetic steel; carbon .95, chromium 3.50; for magnets in meters and other electrical apparatus.

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Presto; carbon 1.05, chromium 1.40; for ball and roller bearings.

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Chrome Vanadium 5-720; carbon .50, chromium .90, vanadium .20; for leaf and coil springs, gears, shafts, etc.

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No. 3-427 chrome molybdenum steel; carbon .30, chromium 1, molybdenum .20; for aircraft and automotive parts.

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No. 436; carbon .15, nickel 1.75, molybdenum .25; for case hardened parts.

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Silico-manganese steel; carbon .60, manganese .75, silicon 2; for heavy duty springs.

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CASTALOY—Detroit Alloy Steel Co., 6500 Wight St., Detroit. Chromium 12 to 14, carbon 1.5 to 1.6; air hardening tool steel castings.

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CATARACT METAL — Niagara Falls Smelting & Refining Corp., Buffalo. Nickel copper for introduction into alloy casting metal.

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CECOLLOY—Chambersburg Engineering Co., Chambersburg, Pa.

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A; carbon 3.00; molybdenum .50, nickel .60; shock resistance, vibration damping, and close grain.

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B; carbon 2.80, molybdenum .50, chromium .35; also has shock resistance, is vibration damping and has close grain in heavy sections.

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C; carbon 3.00, molybdenum .50, nickel 1.50; properties similar to type A.

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CHACE BIMETAL—W. M. Chace Co., 1600 Beard Ave., Detroit. Thermostatic bimetals; a number of combinations including alloys of nickel-iron, nickel-iron-chromium, nickel-iron-manganese, pure nickel, brass, bronze, etc.; responsive to various temperature ranges and provide a wide range of deflection rates and electrical resistivities; for temperature control elements in controllers, recorders, indicators, circuit breakers, etc.

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CHAMET BRONZE—Chase Brass & Copper Co. Inc., Waterbury, Conn. Copper 60, tin .75, zinc 39.25; for general use where strong corrosion resistant brass is required.

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CHASE—Chase Brass & Copper Co. Inc., Waterbury, Conn.

Free-turning bearing bronze; copper 89, lead 2, zinc 9; for automotive and other bearings as well as for screw machine parts requiring good physical properties and high corrosion resistance.

Nickel aluminum bronze; copper 92, nickel 4, aluminum 4; principally corrosion resistant; particularly recommended for condenser tubes in oil refineries or where temperatures are not higher than in the usual surface condensers.

Also various high and low brasses for a variety of mechanical parts.

1 2 - - - - - - 8 -

CHROMAX—Driver-Harris Co., Harrison, N. J. Nickel 35, chromium 15 per cent; castings for furnace parts, conveyor chains, etc.

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CHROMEL—Hoskins Mfg. Co., 4445 Lawton Ave., Detroit.

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No. 502; 18 to 22 chromium, 30 to 34 nickel, balance mainly iron; for burning tools in the enameling industry and for metal furnace parts.

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Grade A; nickel 80, chromium 20; for electric heating elements.

1 2 3 - - - - - -

CIMET—Driver-Harris Co., Harrison, N. J. Nickel 10, chromium 7; castings for furnace parts in high sulphur atmospheres, and for acid resisting castings in the form of pump impellers, piping, etc.

1 2 3 4 5 - - - -

CIRCLE L—Lebanon Steel Foundry, Lebanon, Pa. This trade name covers forty-three different types of alloys including the following:

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No. 1; manganese 1.40, carbon .35, with vanadium or molybdenum.

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No. 2; carbon .32, chromium .75, molybdenum .30, manganese 1.40; for crankshafts, airplane parts, valves, and other castings.

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No. 3; carbon .50, chromium 1.25, vanadium .12, molybdenum .40, manganese 1.40; for gears, cams.

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No. 4; carbon .50 to .80, chromium 1.25 to 2.00, manganese 1.0 to 1.50, vanadium .12, molybdenum .50 to 1; for cams, rolls, etc.

1—Corrosion Resistant; **2**—Heat Resistant; **3**—Abrasion Resistant; **4**—High Tensile Strength; **5**—High Ductility; **6**—Bearing Application; **7**—Electrical Uses; **8**—Heat Treating; **9**—Low Specific Gravity

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No. 6; carbon .5, nickel 1.75, molybdenum .25; for cams, gears and other case hardened parts.

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No. 8; carbon .20, chromium 2.75, molybdenum .40, vanadium .22; nitriding steel.

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No. 10; carbon .20, chromium 5.50, molybdenum .55; for high pressure and high temperature applications in the oil industry.

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No. 11; carbon .75, chromium 18; hard stainless steel; for sand pumps, etc.

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No. 12; carbon .10, chromium 13; stainless steel; chemical apparatus, etc.

1 2 - - - - - - - -

No. 15; carbon .30, chromium 27; heat and corrosion service.

1 2 - - - - - - - -

No. 22; carbon .07 max., chromium 19.50, nickel 9; for miscellaneous stainless parts and castings to be polished.

1 2 - - - - - - - -

No. 23; carbon .15, chromium 19.50, nickel 9; miscellaneous stainless steel castings.

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No. 24; carbon .15; chromium 9, nickel 19.50; stainless steel.

1 2 - - - - - - - -

No. 25; carbon .15, chromium 21, nickel 10; for valves and pump parts for the paper industry.

1 2 - - - - - - - -

No. 30; carbon .15, chromium 24, nickel 10; uses same as No. 25.

1 2 - - - - - - - -

No. 31; carbon .22, chromium 22, nickel 11; resistant to temperatures up to 2000 degrees Fahr.

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No. 32; carbon .50, chromium 15, nickel 35; heat resisting castings requiring strength at elevated temperatures.

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CLOVERLEAF—E. A. Williams & Son Inc., 111 Plymouth St., Jersey City, N. J. Babbitt metal for bushings, bearings, etc.

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COLMONOY—Colmonoy Inc., P. O. Box 977, Los Nietos, Calif. Alloys fabricated of and with metallic boride crystals; varying amounts of the crystals are added to base metal alloys and produced in the form of welding and hard facing rods and electrodes, ingots, special castings, etc.

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COLONIAL—Colonial Steel Co., Grant Bldg., Pittsburgh.

Stainless steel; made in five compositions.

Sil-Man; shock resisting tool steel; a tough and wear resistant silico manganese steel.

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COMMERCIAL—Buckeye Brass & Mfg. Co., 6410 Hawthorne, Cleveland. Cored and solid bronze bars; copper 80, tin 10, lead 10; for bushings, bearings and bars.

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COMPO—Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Self-lubricating bushings, bearings and washers.

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COOPER ALLOY — (Formerly Sweetaloy)—Cooper Alloy Foundry Co., 150 Broadway, Elizabeth, N. J.

No. 16; 18 per cent chromium iron.

No. 17; 18 chromium and 8 per cent nickel.

No. 18; 22 nickel and 10 chromium.

No. 19; 28 per cent chromium.

No. 20; 36 nickel and 18 chromium.

No. 21, 65 nickel and 15 chromium.

No. 22; 28 chromium and 10 nickel; this and above alloys furnished in castings for chemical plant, paper mill, textile and food processing machinery.

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COR-TEN—United States Steel Corp. and subsidiaries (See USS). Carbon .10, max., manganese .10 to .30 phosphorus .10 to .20, sulphur .05 max., silicon .50 to 1; has wide application in machine design, particularly railway cars, mining, dredging and excavating equipment.

For further information see ad on page 64-22D.

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CORVIC BRONZE—Chase Brass & Copper Co., Waterbury, Conn. Copper 98.5, tin 1.5; rod and wire.

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CRISTITE — Commercial Alloys Co., San Francisco, Calif. Tungsten 17, chromium 10, molybdenum 2.5 per cent.

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CROMANSIL — Carnegie-Illinois Steel Corp., Pittsburgh, and Lukens Steel Co., Coatesville, Pa. Carbon .35 max., manganese .90 to 1.50, phosphorus .04 max., sulphur .05 max., silicon .60 to .90, chromium .30 to .70; for high strength construction such as ships, boilers, towers, machine frames, etc.

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CROMIN D—Wilbur B. Driver Co., Riverside Ave., Newark, N. J. Nickel-chromium-iron; high resistivity, for use in low temperature work.

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CROMONITE—Continental Roll & Steel Foundry Co., East Chicago, Ind. Hard alloy chill roll made in three grades, mild, medium and hard; for special applications.

1 2 - - 5 - - - - -

CUPALOY—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Copper base alloy containing chromium and silver; thermal and electrical conductivity 80 to 90 per cent of pure copper; tensile properties of steel; brinell hardness 140-160; applications include spot welding tips, seam welding wheels and rolls, mechanical parts carrying heavy current, etc.; available in form of castings, forgings, bars, strips, etc.

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CUPRON—Wilbur B. Driver Co., Riverside Ave., Newark, N. J. Nickel copper alloy for rheostats, voltmeters, shunts and other resistances operated below red heat; has moderate resistivity.

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CUSILOY—Scovill Mfg. Co., Waterbury, Conn.

1 2 - 4 - - - - - -

Grade 218(A); copper 95.5, silicon 3, iron 1, tin .5; rod and wire.

1 - - 4 - - 7 - -

Grade 626(B); copper 96.75, silicon 1, iron .75, tin 1.5; rod and wire.

1 2 3 4 - - - - - -

CYCLOPS—Cyclops Steel Co., Titusville, Pa.

1 2 3 - - - - - - -

No. 17-A Metal; nickel 20, chromium 8; also has high strength and ductility; for turbine blading, high pressure valves and electrical applications.

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K-Rustless; chrome 7, tungsten 7, carbon .50; is heat resisting; has bearing application.

D

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DAVIS METAL—Chapman Valve Mfg. Co., Indian Orchard, Mass. Corrosion resisting iron; carbon and silicon 0.5, manganese 1.5, nickel 29, iron 2, copper 67 per cent; for valves and fittings.

1 2 - - - - - - - -

DEFIHEAT—Rustless Iron & Steel Corp., 1001 Edison Highway, Baltimore. Carbon .35 max., manganese .25 to .80, phosphorus .035 max., sulphur .035 max., silicon 1.00 max., chromium 23 to 30; will withstand temperatures up to 2100 degrees Fahr. indefinitely.

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DEFIRUST—Rustless Iron & Steel Corp., 1001 Edison Highway, Baltimore. Carbon under .12 max., manganese .25 to .60, phosphorus .035 max., sulphur .035 max., silicon .50 max., chromium 12 to 14; hardening type of stainless steel. Defirust—Machining; carbon .12 max., manganese .25 to .60, phosphorus .035 max., sulphur .25 to .50, silicon .50 max., chromium 12 to 15; hardening type of stainless steel possessing free-cutting properties.

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DEFISTAIN—Rustless Iron & Steel Corp., 1001 Edison Highway, Balti-

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

more. Carbon .20 max. and .08 max., manganese .25 to .60, phosphorus .035 max., sulphur .035 max., silicon .75 max., chromium 17 to 19, nickel 8 to 10; retains high tensile strength and resistance to creep up to 1300 degrees Fahr.; is nonmagnetic. Defistain—Machining: carbon .15 max., manganese .25 to .60, phosphorus .035 max., sulphur .25 to .50, silicon .50 max., chromium 18 min., nickel 8 min.; also has high ductility and free-cutting properties.

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DEWARD—Ludlum Steel Co., Watervliet, N. Y. Carbon .9, manganese 1.50, molybdenum .30; for holders for thread chasers and gang punches.

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DIAMITE—Weatherly Foundry & Mfg. Co., Weatherly, Pa. Nickel 4-6, chromium 2-3 per cent.

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DIAMOND G BRONZE—E. A. Williams & Son Inc., Jersey City, N. J. For bearings, bushings and mill brasses.

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DM STEEL—Timken Steel & Tube Co., Canton, O. Carbon under .15, manganese .30 to .60, silicon .75 to 1.25, chrome 1 to 1.50, molybdenum .40 to .60, phosphorus .04 max., sulphur .04 max.; good resistance to creep up to 1200 degrees Fahr.; for power and refinery equipment such as tubing.

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DOLER-BRASS—Doehler Die Casting Co., 386 Fourth Ave., New York. Copper-zinc-silicon alloy; for die cast machine parts.

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DOLER-NIKLBRASS — Doehler Die Casting Co., 386 Fourth Ave., New York. Copper base alloy containing nickel and manganese; white color; for die castings.

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DOWMETAL—Dow Chemical Co., Midland, Mich.

Alloy F; magnesium 95.7, aluminum 4, manganese .3; sheet and certain extruded shapes for aircraft and transportation industry.

Alloy G; magnesium 89.9, alumium 10, manganese .1; heat treated castings for aircraft and portable machinery requiring high yield strength with moderate impact toughness.

Alloy H; magnesium 90.8, aluminum 6, manganese .2, zinc 3; sand castings for aircraft and portable machinery with improved salt water corrosion resistance; may be heat treated to secure high yield and ultimate strengths with good impact toughness.

Alloy J; magnesium 92.6, aluminum 6.5, manganese .2, zinc .7; forgings, bars, rods, and extruded shapes with improved salt water resistance for aircraft and transportation industry.

Alloy K; magnesium 89.4, aluminum 10, manganese .1, silicon .5; die castings; may be heat treated to increase impact toughness with slight reduction in yield strength.

Alloy M; magnesium 98.5, manganese 1.5; sheet, plate, and rod for special applications for moderately stressed parts requiring resistance to salt water.

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DUPLEX—Crucible Steel Co. of America, 405 Lexington Ave., New York.

No. 1; nickel 3.50, chromium 1.50; forging steel; for shafts and machine parts requiring high strength and toughness; also made in case carburizing type.

No. 2; nickel 1.75, chromium 1; also a forging steel for applications similar to those of No. 1, and made in case carburizing type.

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DUQUESNE SPECIAL — Continental Roll & Steel Foundry Co., East Chicago, Ind. Chrome molybenum steel for rolls subject to severe service; also for abrasive castings.

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DURALOY—Duraloy Co., 12 E. Forty-first St., New York.

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A; 27 to 30 chromium.

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B; 16 to 18 chromium.

C; 12 to 14 chromium.

N; 21 to 24 chromium, 12 nickel.

18-8; 18 chromium, 8 nickel.

15-35; 15 chromium, 35 nickel; for castings.

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DURCO—Duriron Co. Inc., Dayton, O. Alloy steels (KA2S, KA2SMo., etc.); 18 chrome, 8 nickel, carbon max. .07 per cent, and other standard as well as special analyses preferred by users; for pumps, valves, fittings, castings for corrosive service, etc.

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DUREX—Moraine Products Co., 330 East First St., Dayton, O. Copper 85 to 88 per cent, tin 9.4 to 9.8, graphite 2 to 6; bearings for motors, washing machines, electric refrigerators, farm implements, automobiles, etc.

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DURICHLOR—Duriron Co. Inc., Dayton. Silicon 14, molybdenum 4, carbon .80, traces of phosphorus and sulphur, balance iron; for pumps valves, pipe, castings for corrosive service, especially for hydrochloric acid and chloride solutions.

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DURIMET—Duriron Co. Inc., Dayton, O. Nickel 23, chromium 20, silicon 3, molybdenum 1.25, copper 1, carbon .07, balance iron; for pumps, valves, bolts, nuts and castings for corrosive service.

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DURIRON—Duriron Co. Inc., Dayton and licensees including Shawinigan Chemicals Ltd., Montreal, Que. Silicon 14.50, carbon .80, manganese .60, sulphur and phosphorus traces, balance iron; for pumps, valves, exhaust fans, mixing nozzles, and castings for handling acids and other corrosive liquids and gases.

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DURONZE — Bridgeport Brass Co., Bridgeport, Conn. High copper silicon bronzes alloyed with elements such as tin, iron, aluminum, etc.; available in sheet, strip, rod and wire; for propeller shafting, valve parts, gears, etc.

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DUTCH BOY BABBITT — National Lead Co., 111 Broadway, New York. Analysis varies for different bearing applications.

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DYNAMIC STEEL—Continental Roll & Steel Foundry Co., East Chicago, Ind.

C-2; low carbon, manganese, nickel cast steel for parts requiring high physical properties; for tractor frames, locomotive castings, etc.

C-3; medium carbon, manganese, nickel cast steel for resisting wear after a preferential heat treatment; for sprockets, spindles, wheel centers, cross heads, etc.

C-6; high chromium cast steel for special abrasive and crushing work; for sand mills, rock crushers, etc.

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ECONOMO—Wheelock Lovejoy & Co. Inc., Cambridge, Mass. Carbon .20 and .50 with alloy of molybdenum; free machining; for machine tool parts.

ELECTROMET—Electro Metallurgical Co., 19 E. Forty-first St., New York. A line of ferro-alloys and alloying elements of various analyses.

For further information see ad on page 56-14D.

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ELEKTRON—Produced by license and sold in United States by the American Magnesium Corp., 2210 Harvard Ave., Cleveland. Developed by I. G. Farbenindustrie A. G., Bitterfeld, Germany. A series of magnesium base alloys in all cast and wrought forms used largely for motor housings and other structural parts in aircraft and automotive equipment; possesses excellent machinability.

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ELESCO BRONZE—Superheater Co., East Chicago, Ind. Standard mixes such as phosphor bronze, high lead, gear bronze and government specifications; high tensile aluminum bronzes for long wear and acid resistance; super-tensile manganese bronzes for exceptional strength.

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ELINVAR — Produced by Acieries d'Imphy, France; marketed in United States and Canada by R. Y. Ferner Co., 161 Devonshire St., Boston. Alloy with low thermal coefficient of elasticity; nickel 33 to 35, iron 53 to 61, chromium 4 to 5, tungsten

1 to 3, manganese .5 to 2, silicon .5 to 2, carbon .5 to 2; for watch and instrument hairsprings and tuning forks.

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ELKALOY—P. R. Mallory & Co. Inc., Indianapolis. A primary alloy of copper for spot and seam welding sheet steel, terne plate, tin plate, galvanized iron and other materials. A direct substitute for copper, it handles like copper but is harder and lasts longer.

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ELKONITE—P. R. Mallory & Co. Inc., Indianapolis. A class of alloys, one group of which is basically copper and tungsten, producing a welding electrode or die material with good electrical conductivity and hard resistant qualities. Another group, basically silver and tungsten, has been developed primarily as a facing material for heavy-duty contacts. This material can be used either in the form of a thin facing or as an insert with a copper or copper alloy backing material.

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ELVERITE—Babcock & Wilcox Co., 85 Liberty St., New York. Special chilled iron castings; for tube mill linings, car wheels, jaw crushers, sprockets, etc.

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EMPIRE—Empire Steel Castings Inc., Reading, Pa. Alloy steel castings to all standard chrome-nickel specifications; also possess high strength and ductility, and are suitable for heat treating.

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ENDURIA—Bethlehem Steel Co., Bethlehem, Pa. Special carbon spring steel.

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ENDURO—Alloy Steel Div., Republic Steel Corp., Massillon, O. Stainless and heat resisting alloys.

Chromium-nickel group:

18-8; chromium 18, nickel 8, carbon .08 to .20; especially suited to resist atmospheric corrosion, and corrosion re-agents; for dairy and chemical plant equipment, food and meat processing machinery, high strength light weight structural members, and for resistance to oxidational elevated temperatures.

18-8 S; similar to 18-8 except carbon is kept under .08 which permits its use in welded equipment subject to service corrosion.

18-8 S Ti; ;18-8 S to which titanium has been added for eliminating intergranular corrosion at high temperatures; used for airplane collector rings and exhaust manifolds.

18-8 S Cb; 18-8 S plus columbium; for applications similar to those for which 18-8 S Ti is recommended.

18-8 S Mo.; 18-8 S plus 2 to 4 molybdenum; resistant to acids encountered in paper and pulp processes, woolen dyeing and in chemical and pharmaceutical industries; recommended for severe corrosive conditions; good fabricating and welding properties.

18-8 B; 18-8 and 2 to 3 silicon; for resistance to oxidation up to 1650 to 1700 degrees Fahr.; for annealing boxes, furnace parts, etc.

HCN; chromium 25, nickel 12; for resistance to oxidation up to 1950 degrees Fahr.; fabricates, machines, and welds readily.

NC-3; chromium 25, nickel 20 and silicon 2 max.; for maximum heat resistance.

Straight chromium group:

S-1; chromium 11.5 to 13, carbon .12 max., responds readily to heat treatment and is recommended where strength, toughness and hardness are required; for pump shafts, valve seats and stems, nuts and bolts.

FC; free machining grade of S-1 analysis.

AA; chromium 15 to 18, carbon under .10; good corrosion resistance and heat resistant to 1600 degrees Fahr.; for bicycle fenders, oil burner parts, etc.

18-23; chromium 18 to 23; high heat resisting properties; for furnace parts, etc.

HC; chromium 23 to 28; heat resistant to 2100 degrees Fahr.

4-6; chromium 4 to 6 with several carbon ranges up to .25 and with or without addition of molybdenum or tungsten; corrosion and heat resistance considerably superior to that of carbon steels, and with excellent strength at high temperature; for oil refinery and furnace parts.

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ERMAL—Erie Malleable Iron Co., Erie, Pa. Close grained, high tensile, ductile iron; for all general castings.

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ERMALITE—Erie Malleable Iron Co., Erie, Pa. Wear resisting alloy iron; for gears, wearing plates, friction drums and other parts subject to high stresses or wear.

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EVANSTEEL—Chicago Steel Foundry Co., 3720 S. Kedzie Ave., Chicago. Nickel 1 to 1½ per cent, chrome .65 to 1, carbon varies from .30 to .50, sometimes carries additions of vanadium or molybdenum; for castings such as passenger car buckles, tooth bases, sprockets, gears, high pressure valves, etc.

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EVERDUR—American Brass Co., Waterbury, Conn.

Grade A; copper 96, silicon 3, manganese 1; uses include tanks and sewage disposal apparatus.

Grade B; copper 98.25, silicon 1.50, manganese .25; easily fabricated by all methods including welding; used for tubes, bolts and screws.

Grade D; casting alloy; copper 90.94, manganese 1.01, silicon 4.

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FAHRITE—Ohio Steel Foundry Co., Springfield, O.

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N-1; carbon .40 max., nickel 35 to 38, chromium 15 to 18.

N-5; carbon .40 max., nickel 60 to 65, chromium 12 to 14; for mechanical furnace parts.

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N-2; carbon .25 max., chromium 18 to 20, nickel 8 to 10; for valves, pressure castings, etc.

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N-3; carbon .40 max., chromium 24 to 26, nickel 10 to 13; for mechanical furnace castings, etc.

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FARRELL'S 85—Farrell-Cheek Steel Co., Sandusky, O. Specially processed steel castings for resisting abrasion, and possessing high strength, toughness and rigidity.

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FEDERAL-MOGUL — Federal-Mogul Corp., Shoemarker and Lillibridge Sts., Detroit.

F1; a gear bronze suitable for heavily loaded piston pin bushings, etc.

F2; lead bronze for average bushing application.

F3; used largely as backs for babbitt-lined bearings.

F5; widely used for babbitt-lined bearing backs and for bushings where service is not severe.

F6; for average bushing applications.

F8; good casting and machining qualities.

F11; for piston pin bushings and other low speed, heavily loaded applications.

F13; suitable for many of the uses to which F1 is applied.

F15; has 20 per cent lead and may be used safely under adverse lubrication conditions.

F16; because of high lead content may be used where only occasional lubrication is possible.

F18; high lead alloy of good casting characteristics.

F19; strong ductile alloy of average hardness with bearing qualities corresponding to other low lead compositions.

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FIRE ARMOR—Michiana Products Corp., Michigan City, Ind. Nickel 65, chromium 20 per cent.

Type B; nickel 60, chromium 12 per cent.

FIRTHITE—Firth-Sterling Steel Co., McKeesport, Pa. Hard metal composition of sintered carbides furnished in number of grades to form wearing surfaces or the edges of cutting tools.

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FLINTCAST—Pacific Foundry Co., 2100 19th St., San Francisco, Calif. An abrasion resisting iron.

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GOHI—Newport Rolling Mill Co., Newport, Ky. Iron-copper alloy; carbon .02, manganese .025, sulphur .025, phosphorus .005, silicon .003, copper .25; for any sheet or plate application such as in ventilating sys-

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

tems, fabricated sheet metal parts, etc.

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GUNITE — Gunite Foundries Corp., Rockford, Ill. Low carbon high test cast iron; for brake drums, cylinders, dies, hydraulic castings and other machine parts.

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HALCOMB—Halcomb Steel Co., Syracuse, N. Y.
Stainless Steels, Grade A; chrome 12.5. Grade B; chrome 17.
Stainless Irons, FM2; chrome 12; for free machining corrosion resistant parts.
No. 12; chrome 12 to 13.
No. 16; chrome 15 to 16.
No. 18; chrome 18 to 20.
No. 24; chrome 24 to 26.
NCR-238 and Rezistal; stainless steels in various grades for corrosion and heat resistant parts.

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HARDTEM—Heppenstall Co., Hatfield St., Pittsburgh. Carbon .5, nickel chrome molybdenum die steel; for die blocks, shafting, etc.

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HARDWARE BRONZE—Scovill Mfg Co., Waterbury, Conn. Copper 89, lead 2, nickel 1, zinc 8; rod and wire.

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HARDWELD—Lincoln Electric Co., Dept. MD., Coit Rd., Cleveland. High carbon arc welding electrode containing 1 per cent carbon; provides dense, tough surface of moderate hardness to enable various steel parts to resist shock and abrasion; when deposited in straight carbon steel and allowed to cool naturally, provides hardness between 20 and 45 Rockwell C; for cupped or worn rail ends, locomotive or crane tire flanges, car wheels, dies, etc.

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HASCROME—Haynes Stellite Co., Kokomo, Ind. Alloy of chromium, manganese and iron; castings, sheet and hard facing welding rod for parts subject to abrasion and impact.

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HAYSTELLITE—Haynes Stellite Co., Kokomo, Ind. Cast tungsten carbide; for inserts and composite rod (welding rod) for oil-well drilling tools, dredge cutter blades, etc.

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HASTELLOY — Haynes Stellite Co., Kokomo, Ind. For piping, tanks, pump parts, valves, vessels, etc.
A; nickel, molybdenum and iron.
C; nickel, molybdenum, chromium and iron.
D; nickel, silicon, copper and aluminum.

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HAYNES STELLITE—Haynes Stellite Co., Kokomo, Ind. Nonferrous cobalt-chromium-tungsten alloy for corrosion and wear resistant castings, hard facing welding rod for parts subjected to abrasion or a combination of abrasion, heat and corrosion.

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HEPPENSTALL — Heppenstall Co., Hatfield St., Pittsburgh, Pa. Grade 2C30; nickel-chrome-molybdenum steel, .3 carbon; for shafting where high torsional strength is required such as drop hammer piston rods.

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HERCULOY—Revere Copper & Brass Inc., 230 Park Ave., New York. Silicon bronze; copper 96.25, silicon 3.25, tin .50; in addition to properties indicated, it is abrasion resistant and nonmagnetic; made in sheets, strip, plates, cold drawn rods, shafting, welding rod, forgings, ingot form for sand castings; for piston rods, shafting, electrical construction, etc.

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HIGH TEST—International Nickel Co. Inc., 67 Wall St., New York and licensees. Nickel 1 to 1.25, total carbon 2.75 to 3.15, manganese .60 to 1, silicon .9 to 1.10; nickel cast iron possessing high tensile strength; for brake drums, diesel engine liners and heads, paper and printing press rolls, and valve bodies.
For further information see ad on page 62-20D.

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HIOLOY—Ohio Steel Foundry Co., Springfield, O.
Type 0-3; carbon .35 max., nickel 1 to 1.75, chrome .40 to .80, molybdenum .20 to .30; parts for refinery equipment where strength is major consideration.
Type 0-4; carbon .32 max., chrome 4 to 6, molybdenum .50 to .65; for refinery fittings to resist corrosion.
Type 0-6; carbon .75 max., chrome .80 to 1.20, vanadium .15 to .22; for cement mill liners and screen plates, conveyor pipe for abrasive materials, sand mill parts, etc.; available in cast form.

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HIPERNIK—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. A magnetic alloy consisting of 50 per cent nickel and 50 iron; extremely ductile; developed for special magnetic properties at moderately low induction, primarily for radio applications; has maximum permeability of 60,000 or higher at about 4000 gousses, and has low core loss and especially low hysteresis loss; melting point is 1450 degrees Cent.; sometimes used for heater elements for high temperature furnaces with reducing atmospheres.

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HITENSO-BRONZE — American Brass Co., Waterbury, Conn. Copper, cadmium alloys used principally for transmission and trolley wire.

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HOYT BABBITT METAL — National Lead Co., 111 Broadway, New York. Analysis according to bearing application.

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HUBBARD SPECIAL — Continental Roll & Steel Foundry Co., East Chicago, Ind. Nickel chrome steel for wear resisting rolls, guides and miscellaneous castings.

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HYB-LUM — Sheet Aluminum Corp., Jackson, Mich. Corrosion resisting, general purpose alloy containing nickel, copper, manganese, silicon and pure aluminum.
Grade A; high strength; heat treating or non-heat treating.
Grade B; medium strength; heat treating or non-heat treating.

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HYBNICKEL—Victor Hybinette, Wilmington, Del.
Types A, B, C, D, R and S; a series of nickel-chrome alloys for heat and acid resistance.

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HYLASTIC—American Steel Foundries, 410 No. Michigan Ave., Chicago. Carbon .35, manganese 1.50, vanadium .10 to .12, phosphorus and sulphur not over .05; also furnished with the addition of chromium where greater resistance to abrasion is desirable; for rolling mill machinery, automotive and railroad equipment, hammer mills and hydraulic machinery.

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HY-SPEED—Buckeye Brass & Mfg. Co., 6410 Hawthorne, Cleveland. Copper 88, tin 7 and zinc 2 per cent; for bushings, bearings, bars.

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HYTEMCO NILVAR — Driver-Harris Co., Harrison, N. J. Forty-two and fifty-two per cent nickel steel; primarily for electrical uses including resistance thermometers.

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HY-TEN — Wheelock-Lovejoy & Co. Inc., Cambridge, Mass. Chrome-manganese-molybdenum and chrome-nickel-molybdenum alloys with carbon from .10 to 1.

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IDEALOY—Wellman Bronze & Aluminum Co., 6017 Superior Ave., Cleveland. Heavy duty, low speed bushing and bearing bronze; a copper, tin, zinc alloy No. 4-6-10; used where pressure and thrust are excessive.

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ILLIUM—Burgess-Parr Co., Freeport, Ill. Consists primarily of nickel, chromium, copper, molybdenum and tungsten; for resistance to sulphuric acid, nitric acid and other highly

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

corrosive products in the chemical industry.

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INCONEL—International Nickel Co. Inc., 67 Wall St., New York. Composition is nickel 80, chromium 14, iron 6; principal uses include high temperature applications, springs and machinery handling food products; also heat resistant.

For further information see ad on page 62-20D.

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INDUSTRIAL—Industrial Steels Inc., East Cambridge, Mass.

Stainless Steel, No. 35; chrome 13 to 14, carbon .30 to .40. No. 65; chrome 16 to 17, carbon .60 to .70. No. 100; chrome 17 to 18, carbon .9 to 1.

Stainless Iron, No. 12, chromium 11½ to 13. No. 18; chromium 16 to 20. No. 188; chromium 17 to 20, nickel 8 to 10. No. 5188; chromium 17 to 20, nickel 8 to 10. No. 188 M; chromium 17 to 20, nickel 8 to 10, molybdenum 2 to 4 per cent.

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INGACLAD—Ingersoll Steel & Disc Co., division of Borg-Warner Corp., Chicago. Stainless clad steel, consisting of a 20 per cent stainless layer of 18-8 chrome-nickel, or 20-16 chrome-nickel, or straight 16-18 chrome bonded to a back of soft carbon steel; uses include equipment for chemical, food, dairy, processing, brewery and packinghouse industries, besides store fixtures, counters, etc., in units requiring stainless steel surface on one side.

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INLAND—Inland Steel Co., 38 S. Dearborn St., Chicago.

Copper bearing steel; used largely for sheets; copper minimum .20.

Silico-manganese spring steel.

Hi-Steel; nickel copper alloy; made in shapes, plates, bars, etc.

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INVAR—Produced by Acieries d'Imphy, France; marketed in United States and Canada by R. Y. Ferner Co., 161 Devonshire St., Boston. An alloy with a low coefficient of thermal expansion; nickel 36, iron 61 to 64, carbon 0 to 1, manganese .1 to 1, silicon .1 to 1; for clock pendulums, instruments, struts for auto pistons.

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IRALITE—Mackintosh-Hemphill Co., Pittsburgh. Alloy iron; specified where sand iron should be used but unsuitable due to lack of strength.

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IRONITE—Kinite Corp., Foot of Park Place, Milwaukee. Wear resisting castings; nickel, vanadium and chromium composition.

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JALCASE—Jones & Laughlin Steel Corp., Pittsburgh.

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Low carbon open hearth steel which offers machinability practically equivalent to Bessemer screw stock plus the added advantage of rapid case carburizing properties; manufactured as S.A.E. X1314 and S.A.E. X1315 in .10 to .20 carbon grades.

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Open hearth steel which, in the higher carbon ranges, offers exceptional heat treating qualities combined with forging properties and good machinability; manufactured as S.A.E. X1330 (.25/.35 carbon), S.A.E. X1335 (.30/.40 carbon) and S.A.E. X1340 (.35/.45 carbon).

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JAL-TEN—Jones & Laughlin Steel Corp., Pittsburgh. High tensile steel; especially suitable for machine frame or bin construction; adaptable to hot or cold forming and is easily welded or punched for rivets or bolts; made in standard sections and shapes as specified.

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JELLIFF—C. O. Jelliff Mfg. Corp., Southport, Conn.

Alloy A; nickel 80, chromium 20, essentially iron free; non-magnetic; suitable for temperatures up to 2100 degrees Fahr.

Alloy C; nickel 64, chromium 15, iron 20; uses include resistance wire.

Alloy D; nickel 30, chromium 5, iron 65; high electrical resistance; resists oxidation at lower temperatures.

Alloy 45; nickel and copper; temperature coefficient of resistivity is practically nil.

Alloy 70; nickel and copper alloy intended principally for use in electrical heating devices up to 1100 degrees Fahr.

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JEWELL-ALLOY— Jewell Alloy & Malleable Co., Buffalo. Nickel 1.25, total carbon 1.75 to 1.80, silicon .90, chromium .50; castings for machine parts including cams, compressor valve seats and valve inserts.

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JOHNSON—Johnson Bronze Co., New Castle, Pa.

No. 27; copper 80, tin 10, lead 10; deoxidized with phosphorus; general purpose bearing bronze.

No. 19; copper 70, tin 11, lead 19; high wear rating and resistance to pounding; for mill bearings, gas and diesel engines, excavating and pulverizing machinery, etc.

No. 25 (plastic bronze); copper 75, tin 5, lead 19, nickel 1; for high speed with light to medium loads and generally free from shock; because it has good acid resistance it is particularly suitable for pump bearings and sleeves, and also for electric motor, conveyor and fan, and woodworking machinery bearings.

No. 29; copper 78, tin 7, lead 15; for use where spindle is of soft steel and speed is relatively high; acid resisting alloy.

No. 53; copper 88, tin 10, zinc 2; for severe service or heavy pressures; should be used where shaft is hardened steel and well lubricated.

No. 72; copper 83, tin 7, lead 7, zinc 3; best suited for moderate speeds and low loads.

No. 10 (babbitt alloy); tin 90, antimony 5, copper 5; for thin linings and also may be used in die castings.

No. 11; tin 87, antimony 7, copper 6; rather hard babbitt recommended as lining for connecting rods and shaft bearings subjected to heavy pressures.

No. 12; tin 90, antimony 7.5, copper 2.5; for high speeds and high temperatures.

K

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KANTHAL—C. O. Jelliff Mfg. Corp., Southport, Conn. An alloy of chromium, aluminum, cobalt and iron made in three grades A-1, A and D for temperatures of 2462 degrees Fahr., 2372, 2102 degrees Fahr. respectively; made in all commercial sizes of round wire and rod, flat ribbon and strip.

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KINITE—Kinite Corp., Foot of Park Place, Milwaukee. High carbon steel castings resistant to abrasion and compression; for cutters, mandrils, and other machine parts.

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KLEENKUT—Heppenstall Co., Hatfield St., Pittsburgh. Tool steel containing 2 carbon and 12 per cent chromium; for shear knives for cold shearing light material.

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KONAL—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Analysis depends on application—broadly a nickel-cobalt alloy with substantial percentages of iron, titanium, chromium; for thermionic filaments and emitting surfaces, internal combustion engine valves, molds and machine parts subject to stress at temperatures up to 650 degrees Cent.

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KOVAR— Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Low expansion to 400 degrees Cent.; approximately 30 per cent nickel, 15 cobalt and 55 iron; for sealing into hard glass, mercury arc rectifiers, and radio tubes.

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KROKOLOY—Detroit Alloy Steel Co., 6500 Wight St., Detroit. Chromium 12 to 14, carbon 1.5 to 1.6, cobalt 1 to 3.5, molybdenum 1; air hardening tool steel castings.

L

- 2 - - - - - - - -

LO CRO—Crucible Steel Co. of America, 405 Lexington Ave., New York.

46; chromium 5.

46MO; chromium 5, molybdenum .5.

46W; this and above grades are used widely where high strength at elevated temperatures up to 1200 degrees Fahr. is required.

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

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LOTUS BABBITT—Lumen Bearing Co., Buffalo. Lead base babbitt.

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LUBRICO—Buckeye Brass & Mfg. Co., 6410 Hawthorne, Cleveland. Copper 75, lead 20 and tin 5 per cent; for bearings, bushings and bars.

1 - 3 4 5 - - 8 -

LUKENS—Lukens Steel Co., Coatesville, Pa.

1 - - 4 5 - - - -

Cromansil steel (See listing under C), and nickel steel; the latter has good sub-zero impact values.

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Carbon molybdenum steel (high creep resistance), chrome-vanadium steel, manganese vanadium steel (high ratio of yield point to tensile strength).

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Silico-manganese steel.

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Chrome-manganese steels.

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Welding quality steels including "Weldrite;" low tensile strength.

1 - 3 4 - - - - -

Chrome-nickel steel.

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Manganese steel.

1 - - - - - - - - -

Nickel-clad and Inconel-clad steels.

1 - - 4 5 6 7 8 9

LUMEN—Lumen Bearing Co., Buffalo.

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Bronze; a zinc base alloy for bearings.

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Alloys Nos. 00A and 00C; high tin bronzes for high compression bearing applications.

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Alloy No. 1; zinc bronze for pressure castings, etc.

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Alloy No. 2; zinc bronze for machine parts, bearings, etc.

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Alloy No. 3; zinc bronze for mine service and paper mill machinery, and bearings.

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Alloy No. 4; phosphor bronze (leaded).

Alloy No. 4A; high phosphorus bronze (leaded).

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Alloy No. 5; general service alloy; red brass; for low pressure valve bodies, etc.

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Alloy No. 6; phosphor bronze (leaded).

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Alloy No. 7; phosphor bronze; uses include trolley wheels.

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Alloy No. 9; manganese bronze for machine parts.

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Alloy No. 11-C; aluminum bronze; for miter and bevel gears, etc.

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Alloy No. 14; zinc bronze; babbitt backing; for valve bodies, etc.

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Alloy No. 15; phosphor bronze; for worm wheels, bearings, etc.

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Alloy No. 15A; phospher bronze (slightly leaded); for worm wheels, bearings, etc.

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Alloy No. 20; super-managanese bronze; for machine parts.

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Alloy No. 27; aluminum bronze; for strength parts.

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Alloy Nos. 31 and 33; high lead bronzes.

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Alloy No. 48; nickel phosphor bronze; for bearings, worm wheels, etc.

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Alloy No. 54; phosphor bronze (leaded).

- - 3 4 - - - 8 -

LXX—Ludlum Steel Co., Watervliet, N. Y. Tungsten 18, chromium 4, vanadium 1; for lathe centers for severe service.

M

- - 3 4 - - - - - -

MACHEMPITE "Wearprooft"—Mackintosh-Hemphill Co., Pittsburgh. Alloy cast, forged or rolled steel; for gears, locomotive guides, track wheels, sprockets, conveyor parts, etc.

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MACHINEBRONZE—Lumen Bearing Co., Buffalo. Zinc bronze; cored and solid bars.

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MACKENITE METAL—Duncan Mackenzie's Sons Co. Inc., Trenton, N. J. For retorts, annealing pots, cylinders, and lead pan castings.

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MAL-ARC—P. R. Mallory & Co. Inc., Indianapolis. A hard-facing material marketed in the form of an electrode; for application to machine parts where abrasion is encountered.

- 2 3 - - - - - - - -

MALLIX—National Malleable & Steel Castings Co., Cleveland. Pearlitic malleable iron; tensile strength 75,000 pounds per square inch, elongation 5 per cent; for grate bars for sintering machines, elevator buckets, screen plates for pan mills and other castings subjected to heat, abrasion and shock.

- 2 - - - - 6 7 - -

MALLORY 3 METAL—P. R. Mallory & Co. Inc., Indianapolis. An alloy consisting predominantly of copper; used extensively for spot welding tips, flash welding dies and seam welding wheels; This material also is employed in numerous applications where a high strength, high conductivity material is required.

- - - - - - - - 7 - -

MANGANIN—Wilbur B. Driver Co., Riverside Ave., Newark, N. J. Copper, nickel and manganese alloy; for shunts, wheatstone bridges, and precision instruments; possesses moderate resistivity, low temperature coefficient.

1 2 3 - - - - - - - -

MANGANWELD—Lincoln Electric Co., Dept. MD., Coit Rd., Cleveland. Arc welding electrode that produces deposit of austenitic manganese-nickel-molybdenum steel; equal in structure and wear resisting qualities to heat treated cast manganese steel; particularly suitable for adding wear resistance to austenitic manganese steel parts containing 11 to 14 per cent manganese; applications include crusher parts, valves, turbine runners, pulverizer roll shafts, gathering and loading equipment.

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MANGANO—Latrobe Electric Steel Co., Latrobe, Pa. Carbon .95, manganese 1.60, chromium .20; used where nonshrinking, oil quenching steel is required.

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MAN-TEN—United States Steel Corp. and subsidiaries (See USS). Carbon .35 max., manganese 1.25 to 1.7, silicon .15 min., copper .20 min.; used extensively in the design of machinery.

For further information see ad on page 64-22D.

- - 3 4 - - - - - -

MASSILLON—Massillon Steel Casting Co., Massillon, O. Alloy cast steel, heat treated; for domestic, industrial and locomotive stoker worms.

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MAX-EL—Crucible Steel Co. of America, 405 Lexington Ave., New York.

2-B; carbon .40, manganese 1; used in "as rolled" condition for machine tool spindles, lead screws, racks, worms, piston rods, etc.

3½; for heat treated parts on machine tools, such as gears, arbors, spindles, etc.; also available in a case carburizing type.

- - - 4 5 - - - -

MAYARI "A"—Bethlehem Steel Co., Bethlehem, Pa. Chrome nickel steel; for bolts, auto parts, axles, tools, etc.

1 2 3 - - - - - - - -

MEEHANITE—Meehanite Metal Corp., Pittsburgh, and licensees. A sorbo-

1—Corrosion Resistant; **2**—Heat Resistant; **3**—Abrasion Resistant; **4**—High Tensile Strength; **5**—High Ductility; **6**—Bearing Application; **7**—Electrical Uses; **8**—Heat Treating; **9**—Low Specific Gravity

pearlitic iron containing silicon, manganese, phosphorus, sulphur and carbon; composition depends upon mixture and physical constitution as determined by service requirements; twelve grades, each having a separate and distinct combination of physical properties; available in cast form.

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METALINE—R. W. Rhoades Metaline Co. Inc., P. O. Box No. 1, Long Island City, N. Y. Lubricating insert plugs of several diameters and lengths and in varied compositions for rendering bronze bearings and bushings oilless. Also bronze bearings complete in which Metaline plugs are inserted.

1 2 - - - - - - - - -

MICHIANA—Michiana Products Corp., Michigan City, Ind.

No. 48 Alloy; nickel 8, chromium 28.

No. 49 Alloy; nickel 8, chromium 18.

No. 100 Alloy; nickel 12, chromium 24.

\- 2 - - - - - - - - -

No. 55 Alloy; chromium 33.

No. 63 Alloy; nickel 15, chromium 28.

1 2 - - - - - - - - -

MIDVALOY—Midvale Co., Nicetown, Pa. Applications to which the following grades are adaptable include machines in the chemical and refining industries, mining and metallurgical work, rolls for paper machinery, impellers for exhaust gases, mechanical stoker parts, hydraulic machinery parts, etc.

13-00 A; chromium 11.5 to 14, carbon over .35.

Stainless 7; castings only; chromium 20, carbon .25, copper 1.

13-00; chromium 15 max., carbon .12 or under.

17-00; chromium 15 to 18, carbon .12 or under.

21-00; chromium 18 to 23, carbon .12 or under.

26-62; chromium 27, nickel 2 max., carbon as required.

HR1; chromium 20, nickel 7, carbon .35, tungsten 4.

18-08; chromium 18, nickel 9, carbon .06 up.

25-10; chromium 24, nickel 11, carbon low.

25-10-B; chromium 23, nickel 11, carbon .55.

25-20; chromium 25, nickel 20, carbon low, molybdenum .2.

HY-X; chromium 8, nickel 22, carbon .50, copper 1.

ATV-3; chromium 14, nickel 27, carbon .48, tungsten 3.5.

30-30; chromium 30, nickel 28, carbon low.

17-35; chromium 19, nickel 35, carbon low.

ATV-1; chromium 11, nickel 36, carbon .35.

BTG; chromium 11.5, nickel 60, carbon .30, tungsten 2.5.

976; chromium 9.7, nickel 1.5, aluminum 2.3.

KA2, KA2S, KA2Mo, KNC-3; stainless steel for castings only.

18-08-Se; chromium 18, nickel 9, carbon .10, selenium .24.

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MILL BRASS MIX—E. A. Williams & Son Inc., Jersey City, N. J. Bearings, bushings and mill brasses.

1 2 - 4 - - - - - -

MISCO—Michigan Steel Casting Co., Foot of St. Aubin Ave., Detroit.

Grade A; nickel 35 to 37, carbon .50 to .70, chromium 15 to 17; high load carrying capacity up to 1950 degrees Fahr.; for furnace parts, carburizing boxes, retorts.

Grade B; chromium 24 to 26, nickel 12 to 14, carbon .20 to .30; for furnace parts in sulphurous atmospheres.

Grade B-1; chromium 24 to 26, nickel 12 to 14, carbon .40 to .60; for furnace parts in corrosive atmospheres.

Grade C; chromium 28 to 30; nickel 8 to 10, carbon .20 to .30; for valves, fittings and pump parts for sulphite service.

Grade C1; chromium 28 to 30, nickel 8 to 10, carbon .40 to .60; for high heat furnaces where sulphurous compounds are present.

Grade N; chromium 8 to 10, nickel 20 to 22, carbon .30 to .50; for valve and pump parts where alkali and sea water are encountered; heat resistant up to 1500 degrees Fahr.

Grade HN; nickel 60 to 65, chromium 15 to 18; carbon .60 to .80; for retorts, lead baths, etc.

Grade N-5; nickel 30, silicon 3 to 5, carbon .30 to .50; resistant to sulphuric acid; cast and rolled.

Grade 18-8; chromium 18 to 20, nickel 8 to 10, carbon to suit; for valve and pump parts.

1 2 3 - - - - - - -

MISCROME—Michigan Steel Casting Co., Foot of St. Aubin St., Detroit.

Grade 1; chrome 16 to 17, carbon .20 to .30; for pump and valve parts; nitric acid resistant and heat resistant up to 1400 degrees Fahr. as in hot oil-handling equipment.

Grade 2; chromium 18 to 23, carbon .20 to .30; possesses high tensile strength; for pump and valve parts; heat resistant up to 1600 degrees Fahr.

Grade 3; chromium 26 to 30, carbon .20 to .30; for severe nitric acid conditions; heat resistant up to 2200 degrees Fahr.; for ore roaster parts, furnace rails, etc.

Grade CR; 14 to 17 chromium, 2 to 3 carbon; heat and abrasion resistant (mild cases); heat resistant up to 1400 degrees Fahr.

Grade KR; chromium 26 to 30 per cent; carbon 2 to 3; abrasion resistant.

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MOLYBDENITE—Continental Roll & Steel Foundry Co., East Chicago, Ind. Special chrome molybdenum steel castings for mill pinions, guides and rolls.

\- 2 3 4 - - - - - -

MO-LYB-DEN-UM—Climax Molybdenum Co., 500 Fifth Ave., New York. An alloying element for use in steel and iron; imparts strength, toughness, ductility and resistance to abrasion; improves fatigue value, eliminates temper embrittlement, increases physical properties at elevated temperatures; molybdenum steel is easily welded and machined. For further information see ad on page 66-24D.

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MOLYBDIE—A. Finkl & Sons Co., 2011 N. Southport Ave., Chicago.

Type C; carbon .40, manganese .60, chromium .85, nickel 1.50, molybdenum .30, phosphorus and sulphur .04 max.; for machine parts subject to extreme torsional strains, shock and vibration.

Type R; carbon .31, manganese .55, chromium .75, nickel 1.50, molybdenum .30, phosphorus and sulphur .04 max.; uses are similar to above material.

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MOLY-IRON—Weatherly Foundry & Mfg. Co., Weatherly, Pa. Molybdenum 1, chromium 1 per cent.

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MONEL METAL—International Nickel Co. Inc., 67 Wall St., New York. Composition is nickel 68, copper 29, balance iron, manganese, silicon, carbon; general purpose alloy for use under corrosive conditions; also abrasion resistant.

For further information see ad on page 62-20D.

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MORAINE—Moraine Products Co., 330 East First St., Dayton, O. Rolled brass split type bearings and bushings for automobiles and electric motors.

1 - 3 - - 6 - - - -

MUELLER 690 BRONZE—Mueller Brass Co., Port Huron, Mich. Copper 60 per cent, zinc .35, other ingredients 5 per cent; for worm gears, connecting rods, seal rings for refrigerators, crankshafts for oil pumps, etc.

1 2 - - - - - - - -

MUNTZ METAL—American Brass Co., Waterbury, Conn., and Chase Brass & Copper Co., Waterbury, Conn. Copper 60, zinc 40; in sheet form.

N

1 2 3 - - - - - - -

NA, NA-1, NA-2—National Alloy Steel Co., Blawnox, Pa. Varying percentages of nickel and chromium.

\- - 3 4 - - - - - -

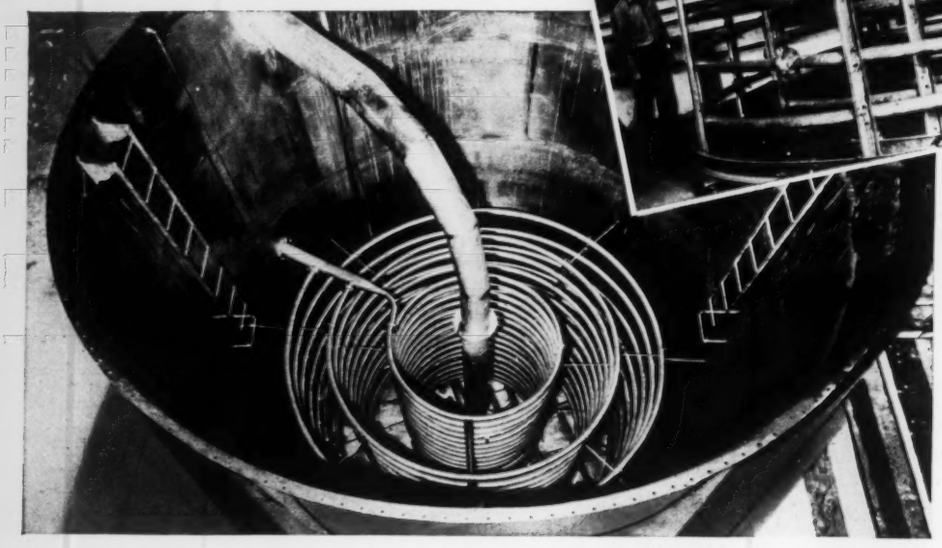
NACO—National Malleable & Steel Castings Co., Cleveland. Specially processed cast steel; for service where heavy blows and constant friction require a material that combines great strength, toughness and resistance to wear.

1 - - - - - - - - 9

NATIONAL—National Smelting Works, 6700 Grant Ave., Cleveland. Aluminum alloyed with various hardeners to meet special casting requirements.

1—Corrosion Resistant; **2**—Heat Resistant; **3**—Abrasion Resistant; **4**—High Tensile Strength; **5**—High Ductility; **6**—Bearing Application; **7**—Electrical Uses; **8**—Heat Treating; **9**—Low Specific Gravity

Better . . . because it's *Stainless Steel*



The coil alone of this installation in a modern brewery consists of over a thousand feet of 3-inch 16-gage 18-8 stainless steel tubing.

This 38,000-gallon yeast propagator is *better because it's stainless steel!* Tank lining, attemperator coil, aerating system, fittings, ladders—all stainless steel...Stainless steel does not affect the color, taste, or clarity of the brew, nor does the brew affect the steel. Better beer is the result!

In thousands of other applications, stainless steel makes a better product and does a better job. If your product must be cleaner and purer . . . if you want strength, lightweight, corrosion resistance, and fatigue resistance in your equipment, it will pay you to consider the possibilities of stainless steel.

Electromet Metallurgists, through years of practical experience with ferro-alloys and alloy steels, can help you apply stainless steel to your equipment or product. Write for the book "Stainless Steels and their Uses" and learn what already has been done.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation

UCC

CARBIDE & CARBON BUILDING **Electromet** Ferro-Alloys & Metals 30 EAST 42nd ST., NEW YORK, N. Y.

1 - - 4 - - 7 - -

NIAGARA—Niagara Falls Smelting & Refining Corp., Buffalo. A line of alloying elements comprising some three hundred and fifty combinations applicable for deoxidizing and fluxing all types of metals intended for casting, and at the same time providing greater resistance to corrosion and higher pressure qualities such as are encountered in pumps and valves.

1 2 - - - - - 7 - -

NICHROME—Driver-Harris Co., Harrison, N. J.

Type A; nickel 62, chromium 15; heating element material; also for electrical devices including rheostats, potentiometers, seamless tubing etc.

Type B; for addition to cast iron; sold in ratios of 5, 3 and 2 parts of nickel to 1 part of chromium.

Type S; sheet; nickel 27, chromium 15; for welded tubing, etc.

Type V; heating element material; also in sheets for welded tubing, etc.

Cast Nichrome; for furnace parts, pyrometer protection tubes, conveyor chains.

Sheet Nichrome; nickel 60, chromium 15; for welded tubing, etc.

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NICRAL—Nicralumin Co., Jackson, Mich. Complete series of light aluminum alloys in various forms and tempers.

1 - - - - 6 - - -

NICUITE—A. W. Cadman Mfg. Co. 2816 Smallman St., Pittsburgh. Nickel bronze; tin 10, nickel 7, zinc 2.5, trace of phosphorus, balance copper; high compressive strength for slow or medium speed operation under extreme load pressures.

- - 3 - - - - - -

NI-HARD—International Nickel Co. Inc., 67 Wall St., New York, and licensees. Nickel 4.5, chromium 1.5, total carbon 2.7 to 3.6; cast iron for chilled rolls, cement grinding balls, etc., where abrasion is encountered.

For further information see ad on page 62-20D.

- 2 - - - - 7 - -

NILVAR—Driver-Harris Co., Harrison, N. J. Nickel 36, balance iron; low expansion is principal characteristic; for astronomical instruments, bimetallic strip, thermostatic controllers for electric ovens, and for sealing through quartz in X-ray tubes.

1 2 - - - - - - -

NI-RESIST—International Nickel Co. Inc., 67 Wall St., New York, and licensees. Nickel 14, copper 6, chromium 2; for castings handling corrosive waters and other solutions, or heats above the range of temperature where ordinary cast iron gives good service.

For further information see ad on page 62-20D.

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NI-TENSYLIRON—International Nickel Co. Inc., 67 Wall St., New York, and licensees. Nickel 1 to 4, total carbon 2.50 to 3.15, silicon 1.20 to 2.75, manganese .5 to .9; for machine tool castings, diesel engine housings, auto cylinder blocks and pistons, etc.

For further information see ad on page 62-20D.

1 - 3 4 - - - - -

NITRALLOY—Nitralloy Corp., 230 Park Ave., New York, controls nitriding process and licenses under which alloy is produced. A chromium - molybdenum - aluminum steel capable of developing extreme hardness through nitriding; for cams and camshafts, gears, pump parts, splined shafts, cylinder liners, etc. Licensees include Bethlehem Steel Co., Crucible Steel Co. of America, Firth-Sterling Steel Co., Ludlum Steel Co., Vanadium-Alloys Steel Co., Republic Steel Corp., Lebanon Steel Foundry, Empire Steel Castings Co., Massillon Steel Castings Co., Milwaukee Steel Foundry Co., Warman Steel Castings Co.

- 2 3 - - - - - -

NOGROTH—Q & C Co., 90 West St., New York. Castings of alloy iron, nickel and chrome; easily machinable.

1 - - - - - - - -

NONCORRODITE—Millbury Steel Foundry Co., Millbury, Mass., Chromium steel castings.

- - - 4 5 - - - -

NORDIC IRON—Reading Iron Co., 401 N. Broad St. Philadelphia. Special grade of bar iron for service where severe vibration is encountered; applications include hangers, brake rods, clevises, spring bands, etc.

O

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OILITE—Amplex Mfg. Co., division of Chrysler Corp., Detroit. Bronze self-lubricating bearings containing one-third liquid lubricant by volume; used extensively in automotive and other industries.

1 - 3 4 - - - - -

OLYMPIC BRONZE—Chase Brass & Copper Co. Inc., Waterbury, Conn. Copper 96, silicon 3, zinc 1 per cent; for bolts, screws, springs, tanks, etc. where high strength and corrosion resistance are determining factors; sheet, rod, wire and tubes.

- - 3 4 5 - - - -

ORION—Cyclops Steel Co., Titusville, Pa. Chrome vanadium steel for machine parts.

P

1 - - 4 5 - - - 9

PERMITE—Aluminum Industries Inc., Cincinnati.

1 - - - - - - - - 9

Aluminum Alloy No. 1021; magnesium 3 to 4, balance aluminum.

- - - 4 5 - - - 9

Aluminum Alloy No. 1010; copper 4 to 5, silicon 1 to 1.5, balance aluminum.

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PIONEER METAL—Pioneer Alloy Products Co. Inc., 16601 Euclid Ave., Cleveland. Approximately 65 nickel, chrome and molybdenum; castings only; readily machinable.

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PLYKROME—Carnegie-Illinois Steel Corp., Pittsburgh. Stainless clad steel embodying a special metallic bond sheet between the veneer of USS stabilized 18-8 and a mild steel backing; for machines employed in the dairy, brewery, chemical and other industries.

1 - 3 - - - 7 - -

PMG METAL—Phelps Dodge Copper Products Corp., 40 Wall St., New York. High tensile silicon bronze having high strength and hardness, low coefficient of friction, resistance to impact, etc.; produced in form of rods, wire, tubing, strip, sheet, sand castings, die castings and centrifugal castings; uses include pump shafting, rods, bolts, nuts, rivets, valve parts, gears, bearings, etc.

- - 3 4 - - - - -

POMPTON—Ludlum Steel Co., Watervliet, N. Y. 10-10½ temper; 1 to 1.05 carbon steel; for arbors, bushings, collets and lathe centers.

- 2 3 4 - - - - -

PROFERALL—Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich. Electric furnace high test cast iron, low carbon; chrome nickel molybdenum alloyed; for crankshafts and camshaft castings, high strength heat, resisting castings, hydraulic press and pressure castings, etc.

- - 3 4 5 - - - -

PROMAL—Link-Belt Co., 220 S. Belmont Ave., Indianapolis. Specially processed malleable iron; will withstand heavy loads without permanent distortion; where additional corrosion resisting properties are desired small percentages of copper can be added; can be hot-dip galvanized and will withstand repeated heating and cooling without growing brittle; uses include chain links, bearing caps, rocker arms, gears, sheaves, levers, and other machine parts subjected to severe service.

1 2 - 4 - - - - -

PYRASTEEL—Chicago Steel Foundry Co., 3720 S. Kedzie Ave., Chicago. Nickel varies from 8 per cent up, chrome from 8 to 26 per cent; available as castings for heat treating furnaces, screw conveyors, or any high temperature service up to 2200 degrees Fahr.

- 2 - - - - - - - -

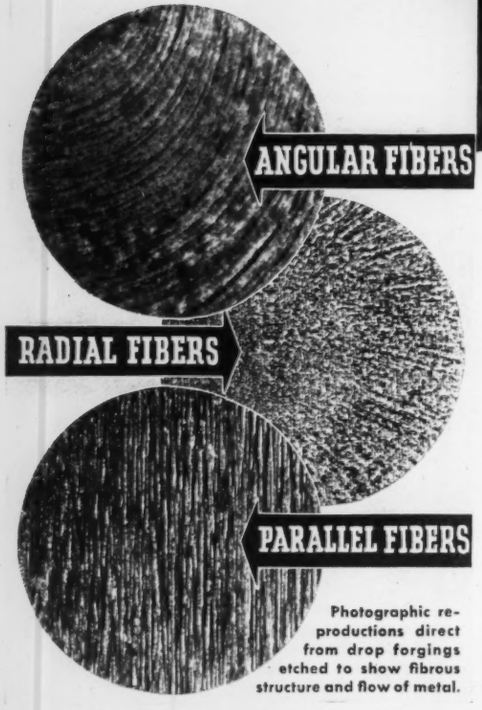
PYROCAST—Pacific Foundry Co., 2100 19th St., San Francisco, Calif. A

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

DROP FORGINGS CAN TAKE IT!

...Millions of Fibers Absorb the Shock

—fibers formed and compacted by rolling and hammering (directional working) the steel. They provide hoarded strength where the shock comes.



Photographic reproductions direct from drop forgings etched to show fibrous structure and flow of metal.

PLAN TO USE a drop forging where the impact occurs! Drop forgings possess exclusive characteristics which impart enduring strength, flexibility and stamina more generously. These characteristics are developed only by the drop forging process. Where vibratory strain concentrates, where pull and pressure build up, accept no less assurance of dependability than that which a drop forging gives you. Know how to utilize all the characteristics of drop forgings in designing new products—write for booklet.

DROP FORGING ASSOCIATION
605 Hanna Building • Cleveland, Ohio

• This symbolic emblem identifies members of the Drop Forging Association.

DROP FORGINGS ARE THE SINEWS OF COUNTLESS USEFUL THINGS

chrome nickel iron resistant to high temperature.

1 2 - - - - - - - -

PYRODIE—Heppenstall Co., Hatfield St., Pittsburgh. Nickel chrome molybdenum steel, .6 carbon; for insert and hot die-steel service.

- - 3 4 - - - - 8 -

PYTHON—Ludlum Steel Co., Watervliet, N. Y. Chromium, .25, vanadium .25; for chuck jaws, clutch pins and other parts requiring unusual wear and shock resistance.

Q

1 2 3 - - - - - - -

Q-ALLOY—General Alloys Co., 367-405 W. First St., Boston.

Grade A+; nickel 65 to 68, chromium 15 to 19, balance mainly iron; for parts operating in temperatures up to 2200 degrees Fahr.

Grade B; nickel 59 to 62, chromium 10 to 14; for same application as Grade A but lower heat hour life.

Chrome CN1; chromium 24 to 26; nickel 11 to 13, balance iron and small percentage of special alloying elements when required; for general resistance to weathering and corrosive attack of most common acids; also fairly good resistance to high temperatures.

Chrome CN2; chromium 18 to 20, nickel 8 to 10, balance mainly iron and special alloying elements when required; resists attack of most common acids.

Chrome C1; chromium 26 to 30, with or without low nickel content; for parts in contact with mine water and certain other special acids; fair resistance to high temperatures.

Chrome C2; chromium 16 to 18; for parts in contact with nitric acid, etc.

Chrome C3; chromium over 30, carbon 2 to 3; ordinarily machinable only by grinding.

R

- - 3 - - - - - - -

RCF—George H. Smith Steel Casting Co., 1320 S. First St., Milwaukee. Chrome nickel alloy possessing wear resisting qualities.

- - 3 4 - - - - - -

RED ANCHOR—Anchor Drawn Steel Co., Latrobe, Pa. Carbon .95 to 1.10; commercial carbon drill rods; for precision shafts for motors, spindles, anvils and dental tools.

- - - 4 - - - - - -

RESILIA—Bethlehem Steel Co., Bethlehem, Pa. Special analysis silico-manganese spring steel.

- - 3 4 - - - - - -

RESISTO-LOY — Resisto - Loy Co., Grand Rapids, Mich. A hard-surfacing alloy with chromium 4, nickel 3.2; cobalt 11, tungsten 17, copper 59.19, lead .01, iron 2, arsenic-sulphur .08, silicon .01, phosphorus .03; manganese 1.5 per cent; for application by electric arc or acetylene torch to shovel teeth, third rail shoes, agricultural machinery parts, etc.

1 2 - - - - 6 - - -

REZISTAL—Crucible Steel Co. of America, 405 Lexington Ave., New York.

Stainless irons; No. 12; 12 to 15 chromium. No. 17; 16 to 18 chromium. No. 20; 18 to 23 chromium. No. 27; 23 to 30 chromium. No. 162; 16 chromium, 2 nickel. No. 182; 18 chromium, 2 nickel. All have .12 max. carbon.

Stainless Steels; a group similar to the foregoing except having a higher carbon content; used principally for bearings, etc., where hardness and resistance to corrosion are desired.

Stainless A; .3 carbon, 12 chromium. B; .60 carbon, 16 chromium. B-109; 1 carbon, 17 chromium.

KA-2 (chromium 18, nickel 8) and its modifications. No. 3; chromium 22, nickel 12, silicon 2.50. No. 4; chromium 20, nickel 25, silicon 2.50. No. 7; chromium 25, nickel 25, silicon 1. No. 2600; chromium 8, nickel 18.

1 2 3 - - - - - - - -

RITA—Cannon-Stein Steel Corp., Marcellus and Wyoming Sts., Syracuse, N. Y.

No. 2; A .20 carbon high manganese low chrome nickel steel; excellent machining qualities; for unhardened, carburized or case hardened parts.

No. 4; .4 carbon high manganese low chrome nickel steel; for pistons, arbors, spindles, etc.

No. 5; .50 carbon high manganese low chrome nickel steel; exceptional strength and toughness, and highly resistant to shock and repeated stresses; for shafting, spindles, piston rods, etc.

No. 7; higher carbon, chrome and nickel steel that can be hardened in water or oil; for lathe centers, pneumatic hammer pistons, etc.

1 - 3 - - - 7 - -

RIVERSIDE—Riverside Metal Co., Riverside, N. J.

Beryllium copper; heat treatable copper alloy; has high tensile strength and ductility; for electrical parts, springs, diaphragms, jet tips, valve sleeves and seats, etc.

Phosphor bronze; copper tin alloy to which phosphorus has been added; has high strength and ductility; used in electrical appliances and machinery as springs, bearings, diaphragms, textile ring travelers, etc.

Nickel silver; copper, nickel, zinc in varying proportions; for diaphragms, radio and telephone springs, screw machine products, etc.

1 - - 4 5 - - - - -

ROMAN BRONZE—Revere Copper & Brass Inc., 230 Park Ave., New York. Copper 60, tin .75, zinc 39.25; for forging, flanging, upsetting; uses include piston rods, shafting, bearing applications, etc.

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RUSELITE—Ruselite Corp., 1015 North Fourth St., Milwaukee. Chromium 1.25 to 1.50, molybdenum .10, copper 3.50, balance aluminum; for die and sand castings that ordinarily would be chromium plated.

1 2 3 - 5 - - - - -

RUSTLESS—Rustless Iron & Steel Corp., 1001 Edison Highway, Baltimore.

1 2 3 - - - - - - - -

RR-11; carbon .07 max., phosphorus .035, sulphur .035, silicon .50 max., chromium 11 to 12; a low hardenability stainless steel especially developed for structural use; also has high tensile strength and ductility.

1 2 - - 5 - - - - -

15; carbon .12 max., manganese .25 to .60, phosphorus .035 max., sulphur .035 max., silicon .50 max., chromium 14 to 16; semi-hardening type of stainless steel, especially suitable for cold heading operations.

S

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SABECO—Fredericksen Co., Saginaw, Mich.

No. 5 bearing bronze; copper 69 to 71, tin 4.5 to 5.5, lead 24 to 26, max., impurities .2; for light or medium load and water lubricated bearings.

No. 9; copper 69 to 71, tin 8.5 to 9.5, lead 20 to 22, max., impurities .2; for heavy loads such as average machine tool requirements.

No. 11; copper 69 to 71, tin 10.50 to 11.50, lead 18 to 20, max. impurities .2; for extra heavy unit pressures.

No. 11HG; copper 69 to 71, tin 10.5 to 11.5, lead 18 to 20, max. impurities .2; for worm wheels, clutch shifter shoes, forging machine slides, etc.

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SATCO—National Lead Co., 111 Broadway, New York. White metal bearing alloy; high melting point; non-deforming; suitable for die casting; primary application is bearing liners.

- - 3 4 - - - 8 -

SEMINOLE—Ludlum Steel Co., Watervliet, N. Y. Chromium 1.30, tungsten 2, vanadium .25; for high creep strength bolts and studs for superheated steam; also machine parts having high wear and fatigue values.

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SEYMOURITE—Seymour Mfg. Co., Seymour, Conn. Copper 64, nickel 18, zinc 18.

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SHAWINIGAN NIROSTA—Shawinigan Chemicals Ltd., Montreal, Que. Chrome nickel steels; for application where corrosion and heat are encountered.

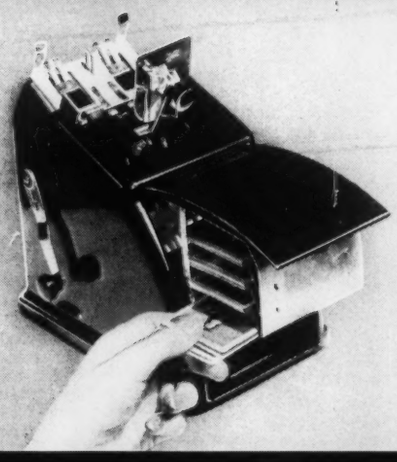
1 2 - - - - - - - -

SICROMO STEEL—Timken Steel & Tube Co., Canton, O. Carbon, .15 max., manganese .50 max., silicon .50 to 1.00, chrome 2.25 to 2.75, molybdenum .40 to .60, suitable for

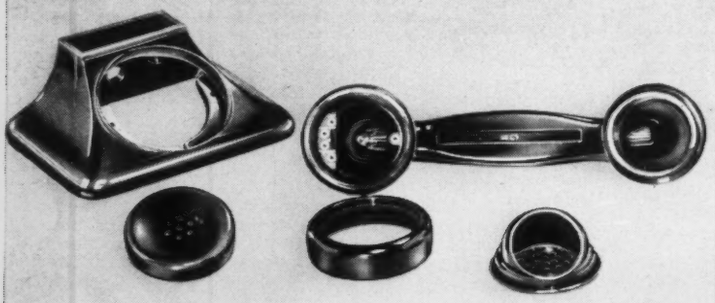
1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

FOR SALES APPEAL

Several materials were considered for the housing of this I-deal card shuffler. The chief factor in making the selection was *sales* appeal. Durez was selected because its smooth, lustrous finish and sleek "quality" appearance have such a definite attraction for the customer at the point of sale. *The I-deal machine was invented by Professor Woodruff of M. I. T. and is designed to scientifically shuffle and deal cards.*



DURABILITY...



Nothing is subjected to much harder punishment than that 24-hour-a-day servant... the telephone. That's why Leich Electric molded this new telephone hand set of a special double-strength Durez. No amount of banging the arm down on the stand will ever crack it... its smooth finish will never chip, dent, or wear off, for it goes all the way through the piece ... is not applied.

ECONOMY...

This molded Durez case has three big advantages over a metal one: 1. A permanent, lustrous finish. 2. More quiet operation. 3. Lighter weight. But, in addition . . . molding it of Durez eliminated nine production operations . . . made possible a considerable saving in the cost of the machine.

For further information on this modern molding machine compound, write General Plastics, Inc., 173 Waick Rd., N. Tonawanda, N. Y.

MOLD IT OF DUREZ.....

cracking furnace tubes, high temperature heat exchangers, etc.

1 2 - 4 - - - - - -

SILCROME—Ludlum Steel Co., Watervliet, N. Y.

L12; carbon .35, chromium 13; also abrasion resistant and has high ductility; suitable for pump shafts and machine parts including bearings.

M17; carbon .70, chromium 17; for pump shafts, oil machinery, etc.

CC; chromium 12, copper 1, low carbon; also abrasion resistant; for pump shafts and plungers for hot and cold liquids; especially suited for noncorrosive springs exposed to elevated temperatures.

H17; carbon 1, chromium 17, silicon 1; for pump shafts, etc.

12; carbon .12, chromium 14; also has high ductility.

RA; chromium 16, copper 1, low carbon; for valves, spindles, etc.

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SIL-TEN—United States Steel Corp. and subsidiaries (See USS). Carbon .40 max., manganese .60 min., silicon .20 min.; used in the design of machinery.

For further information see ad on page 64-22D.

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SIMPLEX—Crucible Steel Co. America, 405 Lexington Ave., New York. Nickel 1.25, chromium .75; forging steel for machine parts requiring high strength and toughness; also available in case carburizing type.

1 2 3 4 5 - 7 - - -

SIVYER—Sivyer Steel Castings Co., 1675 S. Forty-third St., Milwaukee.

1 - - - - - - 7 - -

"Sixty"; chromium 18, nickel 8, carbon .12 max.; an austenitic nonhardenable corrosion resistant cast steel; also nonmagnetic.

1 2 - - - - - - - -

"Sixty-four"; chromium 27, nickel 10, carbon .25 max.; characterized by high strength and better corrosion resistance than "Sixty".

1 - - - - - - - - -

"Sixty-six"; chromium 11.5 to 13.5, carbon .12 max.; hardenable cast steel of medium corrosion resistance.

Five per cent chrome moly; a 5 per cent chromium, .5 molybdenum steel for oil refinery and power plant service.

- 2 - - - - - - - -

"Seventy"; chromium 15, nickel 35.

- - 3 - - - - - - -

Hi-carbon chrome moly; a 70 per cent chrome molybdenum air hardening cast steel for severe abrasion; for rolling mill rolls, wearing plates, etc.

6140; fine grained cast chrome vanadium steel for road machinery or excavator teeth, etc., combining abrasion resistance with good ductility.

- - - 4 - - - - - -

3140; chrome nickel general purpose steel; composition properly balanced for liquid quenching.

Miraculoy; chrome nickel manganese molybdenum steel having high physical properties after air or oil quenching and tempering.

- - - - - 5 - - - -

Manganese nickel; manganese 1.2, nickel .75; suitable for differential water quenching.

Manganese vanadium; manganese 1.25, vanadium .10; cast steel with combination of strength and ductility.

- - - - - - - 7 - -

Dynamo; a low carbon, low manganese steel with low residual magnetism.

- 2 - - - - - 7 8 -

SMITH ALLOY 10—Hevi Duty Electric Co., 4212 W. Highland Blvd., Milwaukee. Chromium 37.5, aluminum 7.5, iron 55; for resistor elements in heat treating furnaces at temperatures of 2300 to 2400 degrees Fahr.

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SMITHCO DYNAMO—George H. Smith Steel Corp., 1001 Edison Highway, Milwaukee. An alloy steel possessing high magnetic permeability.

1 2 - - 5 - - - - -

SPECIAL DEFIRUST—Rustless Iron & Steel Corp., 1001 Edison Highway, Baltimore. Carbon .12 max., manganese .25 to .60, phosphorus .035 max., sulphur .035 max., silicon .50 max., chromium 14 to 16; nonhardening type of stainless steel; highly resistant to corrosion; heat resistant up to 1500 degrees Fahr.

- 2 - - - - - - - -

STANDARD-ALLOY—Standard Alloy Co., 1679 Collamer Ave., Cleveland. Nickel 20 to 60, chromium 16 to 25 per cent; for heat and acid resisting castings.

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STANNUM BABBITT—Lumen Bearing Co., Buffalo. Tin base babbitt.

1 2 3 - - - - - - -

STERLING—Firth-Sterling Steel Co., McKeesport, Pa.

Type A(420); good physical properties in heat treated state; maximum resistance to corrosion secured by hardening and through grinding; for wear resisting parts.

Type T(410-425); high tensile strength type; for valves, trim, pump rods, pistons, etc.

Type TX(403); developed for turbine blading.

Type FC(416); type T modified for applications where free cutting properties are required.

Type M(430); soft ductile steel that does not work-harden readily; requires no heat treatment to secure corrosion resistance.

Type MG(442); used where strength and toughness are secondary to workability and high temperature resistance.

Type KA2(302); an 18-8 steel; used particularly in oil and chemical industries; in hard wire this material is especially suitable for springs.

Type FC(303); free machining 18-8 steel.

Type KA2s(304); malleable for both hot and cold working.

Type 19-9(305); supplied where minimum 18 per cent chromium and minimum 8 per cent nickel are specified.

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STOODITE — Stoody Co., Whittier, Calif. A hard-facing overlay metal applied to earth moving, earth working or digging equipment by either oxyacetylene or electric welding.

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SUMET—Sumet Corp., 1543 Filmore Ave., Buffalo.

SM-4; lead 28 per cent; for light and medium duty bearings in high speed service.

SM-8; lead 26; for moderately severe service.

SM-10; lead 24; for bearings subject to shock and impact.

SM-12; lead 22; for slow speed under heavy load and impact.

SM-14; lead 14; for severe service subjected to heavy shock.

SM-16; lead 20; for heavy duty slow speed service.

SM-18; lead 17½; for extremely severe service; uses include roll neck bearings; also suitable for gear blanks.

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SUPERLOY—Washington Iron Works, Seattle, Wash.

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K2Mo; corrosion resistant stainless steel; castings.

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Manganese steel; abrasion resistant steel castings.

No. 10; high carbon chrome nickel molybdenum steel; abrasion resistant steel castings.

- - - 4 - - - - - -

No. 4; chrome nickel molybdenum steel; high tensile strength steel castings.

- 2 - 4 - - - - - -

SUPERTEMP—Bethlehem Steel Co., Bethlehem, Pa. An alloy steel having high tensile strength at high temperatures; suitable for bolts and studs for reaction chambers, cracking stills, superheaters, etc.

SWEETALOY—(See Cooper Alloy).

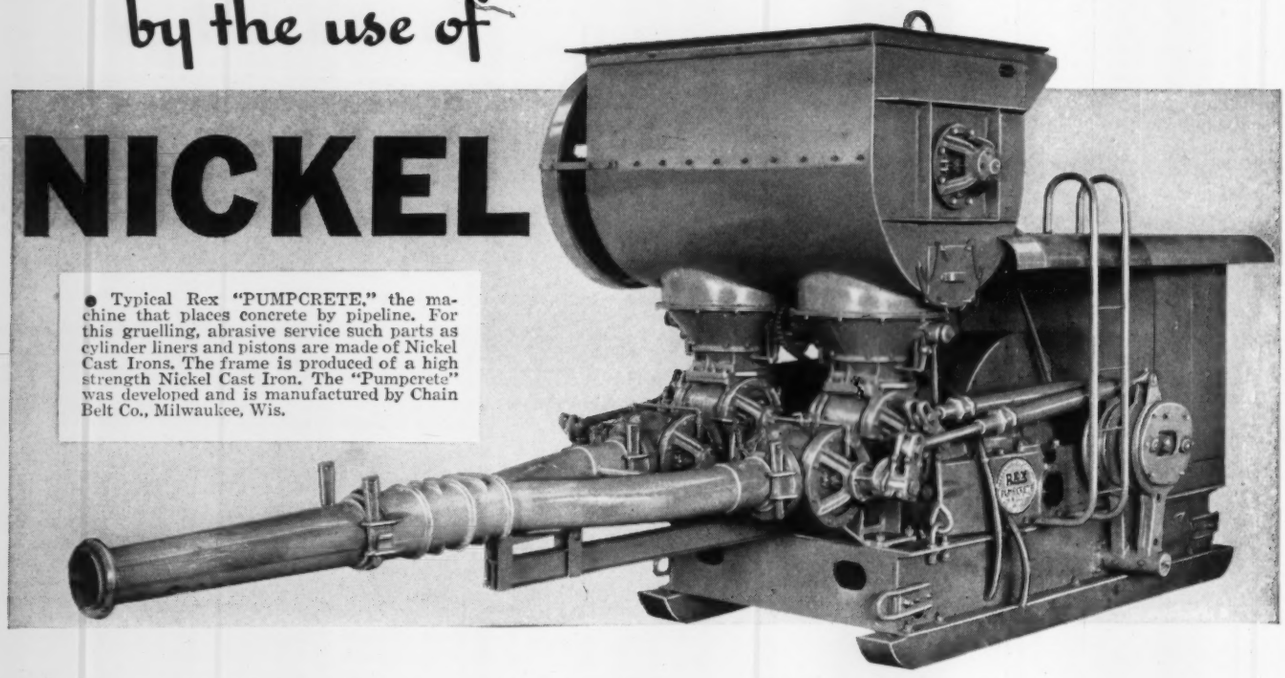
T

1 - - 4 5 - - - - -

TAMCO—Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Alloys including original high and medium carbon ferro carbon-titanium, foundry ferro titanium, and several varieties of low carbon ferro titanium for rolled, cast and forged steels, stainless and alloy steels, and gray cast iron. For the nonferrous field, alloys include TAM Webbite (alumino-titanium) for aluminum castings, cupro-titanium for copper, nickel-titanium, molybdenum-titanium, and special alloys for special

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

Unique Machine curbs ABRASION of PUMPING CONCRETE by the use of NICKEL



● Typical Rex "PUMPCRETE," the machine that places concrete by pipeline. For this gruelling, abrasive service such parts as cylinder liners and pistons are made of Nickel Cast Irons. The frame is produced of a high strength Nickel Cast Iron. The "Pumpcrete" was developed and is manufactured by Chain Belt Co., Milwaukee, Wis.

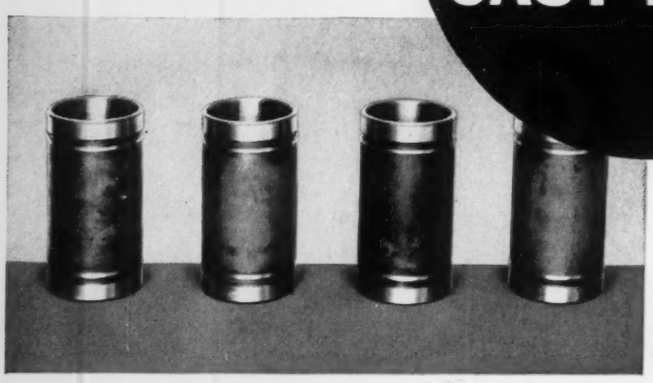
● The new Rex "Pumpcrete," introduced by Chain Belt Co., Milwaukee, Wis., offers concrete evidence that Nickel Cast Irons can "take it" when it comes to handling abrasive materials. The frame, cylinder liners and pistons are made of strong, highly wear-resistant Nickel Cast Irons.

● This remarkable unit which is capable of pumping concrete up through steel pipe some 15 or 20 stories has been used with success on many large construction projects.

Our casting specialists are always glad to recommend suitable compositions of nickel steels and cast irons for any service.

NICKEL CAST IRONS

● These PISTONS, used in the Rex "Pumpcrete," are cast of 2½% Nickel Iron, heat-treated. Brinell hardness 350. Approximately 8 in. dia. x 3 ft. long, these Nickel Iron castings possess a dense, uniform, close-grained structure that offers excellent resistance to the abrasive action of concrete. Note particularly the extremely high polish.



● *(Left)* The LINERS in the cylinders of the "Pumpcrete" are cast centrifugally of a wear resisting or Nickel iron possessing a minimum hardness of 500 BHN. Like their mating parts, the pistons shown above, these cast Nickel iron liners offer remarkable resistance to the abrasiveness of concrete.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

purposes, in addition to metallic titanium and metallic zirconium.

1 - 3 - - - - - - -

TANTIRON—Bethlehem Foundry & Machine Co., Bethlehem, Pa. Iron 84.9, silicon 13.5, carbon .8 to 1, manganese .4, phosphorus .18, sulphur .05; castings for vessels, liners, inserts, chutes, feed pipes, etc.

1 - - 4 - - - 8 -

TEMPALOY — American Brass Co., Waterbury, Conn. Copper aluminum and nickel alloys which yield to heat treatment; uses include motor boat shafting, piston rods, etc.

- 2 3 - - - - - -

TEMP ALLOY—Continental Roll & Steel Foundry Co., East Chicago, Ind. Chrome alloy heat resisting cast iron used for furnaces and other designs subject to high temperatures and abrasion.

- - 3 4 - - - 8 -

TETON—Ludlum Steel Co., Watervliet, N. Y. Carbon 1, chromium 1.40; for balls and ball races, bushings, cams, etc.

1 2 - - - - - - -

THERMALLOY — Electro-Alloys Co., Elyria, O.

Grade A; 64 to 66 nickel, 17 to 20 chromium.

Grade 72; 58 to 62 nickel, 12 to 15 chromium.

Grade B; 38 to 42 nickel, 16 to 19 chromium; for rollers, chain, skid rails and disks.

Grade 50; 33 to 37 nickel, 14 to 16 chromium.

Grade C; under 2 nickel, 25 to 30 chromium; used in chemical industry for rabble arms, etc.

Grade D; 2 to 5 nickel, 25 to 30 chromium.

Grade E; 8 to 12 nickel, 24 to 28 chromium.

- - 3 - 5 - - - -

TIGERLOY—Massillon Steel Casting Co., Massillon, O. Nickel- molybdenum; for shovel castings, gears, crane track wheels, castings for impact resistance, etc.

- - 3 - - - - - -

TIMANG—Taylor-Wharton Iron & Steel Co., High Bridge, N. J. Nickel manganese steel; can be rolled, drawn, forged or shaped; for journal box liners, pedestal gib liners, conveyor flights, welding rod, etc.

- 2 - 4 - - - - -

TIMKEN 17-22—Timken Steel & Tube Co., Canton, O. Carbon .40 to .50, manganese .30 to .60, silicon .50 to 1, chrome 1.10 to 1.40, tungsten .80 to 1, vanadium .25 to .35; good resistance to creep up to 1200 degrees Fahr.; suitable for highly stressed bolts, studs, screws; can be air treated to meet specifications.

1 - 3 - 5 - - - -

TISCO—Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

1 - - - - - - - -

Stainless steel castings of all compositions.

- - 3 - 5 - - - -

Manganese steel castings for shock and abrasion resistance.

1 - - 4 5 - - - -

TOBIN BRONZE—American Brass Co., Waterbury, Conn. Copper 60, zinc 39.25, tin .75; uses include piston rods, boat shafting, condenser head plates, forgings, seamless tubes, etc.

- 2 3 4 5 - - 8 -

TOLEDO ALLOY — Industrial Steel Casting Co., Toledo, O.

- - 3 - - - - 8 -

No. 3; carburizing steel, heat treated to give good machinability and uniform grain; excellent results obtained with short cycle carburizing treatment.

No. 4; abrasion resistant silicon-molybdenum steel with good hardening properties; used for mining tools, wear plates, crusher plates and pinions.

- 2 3 - - - - - -

No. 6; air hardening die steel of uniform machining qualities; long life under severe wear and heat.

- - - 4 - - - 8 -

No. 7; triple heat treated carbon vanadium steel for many applications in the railroad and locomotive industry where extensive and repeated stress is encountered.

- - 3 4 5 - - - -

No. 8; pearlitic manganese steel with analysis adjusted to give high tensile strength and ductility; used in automotive and aircraft equipment and other machines.

For further information see ad on page 68-26D.

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TONCAN IRON—Republic Steel Corp., Republic Bldg., Cleveland. An open hearth iron alloyed with .40 min. copper and .05 min. molybdenum.

1 2 3 - - - - - - -

TOOLWELD — Lincoln Electric Co., Dept., MD., Coit Rd., Cleveland. Coated arc welding electrode providing a deposit with hardness of 55 to 65 Rockwell C; hardness retained under relatively high temperatures (approximately 1000 degrees Fahr.); deposit can be heat treated same as high speed steel; for building hard, tough cutting edges on cold rolled steel; also useful for other applications where super-hardness is required.

1 2 - - - - - 7 - -

TOPHET—Wilbur B. Driver Co., Riverside Ave., Newark, N. J.

Type A; approximately 80 per cent nickel and 20 chromium; for electrical heating applications.

Type C; nickel, chromium and iron; for electrical resistance and heating applications; heat resistant.

- - 3 - - - - - -

TRIMMAX—Heppenstall Co., Hatfield St., Pittsburgh. Abrasion resistant alloy tool steel for cold trimmer service.

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TRODALOY No. 1—General Electric Co., Schenectady, N. Y. Resistance welding electrode alloy containing 2.6 per cent cobalt, .4 beryllium, 97 copper, has 55 per cent conductivity of copper; 45,000 pounds per square inch proportional limit; 220 brinell hardness; used for switch blades, cams, spring fingers, etc.

- - 3 4 - 6 7 - -

TRUALOY—True Alloys Inc., 1820 Clay Ave., Detroit.

- - - - - - - 7 - -

Copper; has high conductivity; castings for welding machines and conduction of current.

- - 3 - - 6 - - -

Bearing bronze; low friction and wear, with high compressive strength, resistance to pounding, and easy to machine.

- - - - 4 - - - - 9

Aluminum; castings possessing strength and hardness.

- - 3 4 - - - - -

TUFALOY—Fort Pitt Steel Casting Co., McKeesport, Pa. Alloy cast steel possessing a high yield point and wear resisting qualities.

1 - 3 4 - - - - -

TUF-STUF—Mueller Brass Co., Port Huron, Mich. Copper 87 per cent, iron 3, aluminum 10; for application where high tensile strength, resistance to abrasion and to sulphuric acid are required.

U

1 2 3 - - 6 - 8 -

UNILOY—Cyclops Steel Co., Titusville, Pa.

1 - - - - 6 - 8 -

1435 (stainless grade A); chrome 13.50, nickel .50 max.

1 - 3 - - 6 - - -

1860 (stainless grade B); chromium 17, nickel .50 max.

Special (18-8); chrome 18, nickel 8; heat resisting up to 1600 degrees Fahr.

1 2 - - - - - - -

24-11; chrome 24, nickel 11; heat resisting up to 1800 degrees Fahr.

1 - - - - - - - 8 -

1409; stainless iron; chromium 12 to 14, carbon .10.

1809; high chrome stainless iron; chromium 16 to 1800, carbon .10.

- 2 - - - - - - -

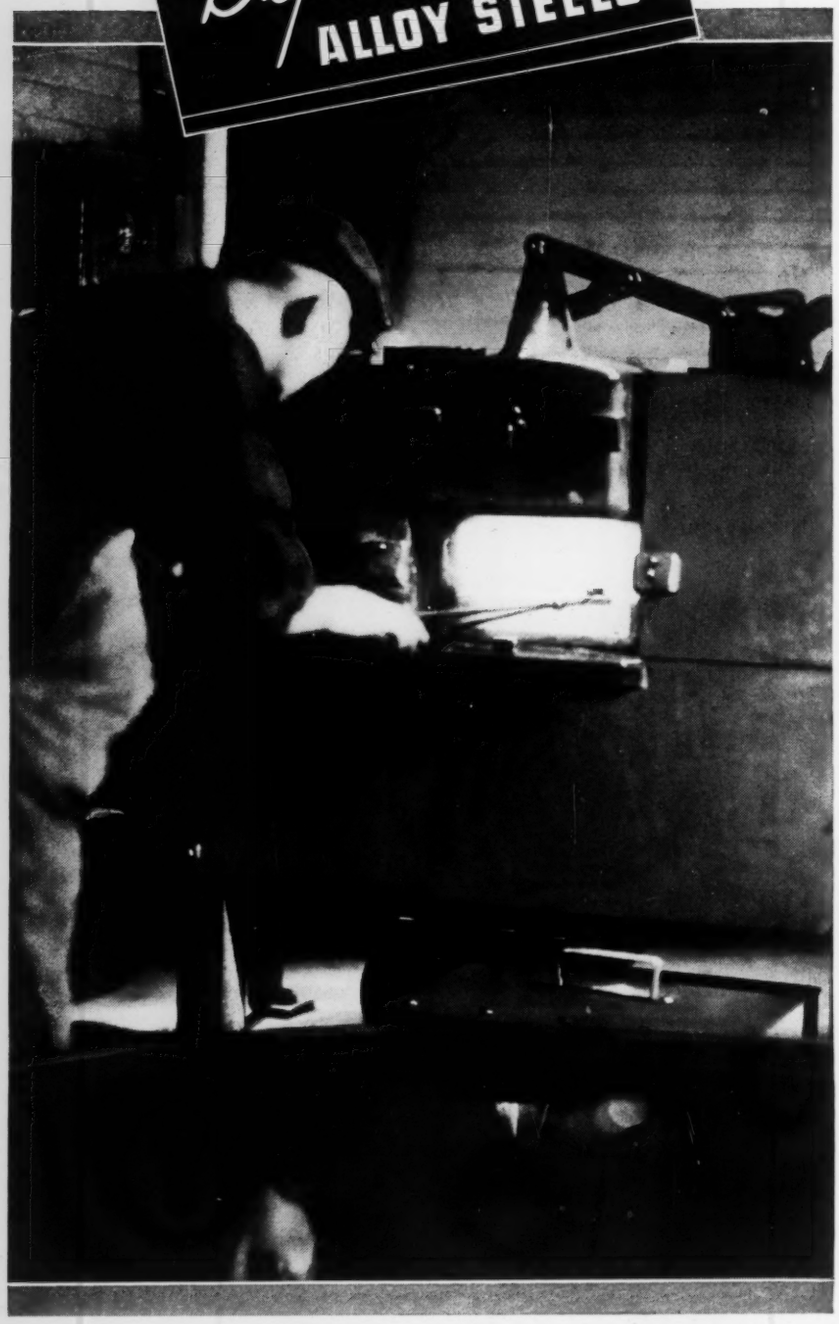
2825; high chrome iron; chromium 28; heat resisting to 2000 degrees Fahr.

- - - 4 5 - - - -

UNIVAN—Union Steel Casting Co., Sixty-second and Butler Sts., Pittsburgh. Nickel vanadium alloy; for locomotive frames, crossheads,

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity

Dependable ALLOY STEELS



GETTING READY FOR THE PHYSICALS. *After the chemistry of a heat of Carnegie-Illinois Alloy Steel has been checked, samples cut from billets are taken for analysis in the physical laboratories. But first they are subjected to heat treating under carefully controlled pyrometric conditions. In these heat treating laboratories the steel is checked for structure, physical properties and performance under working conditions imposed by the customer.*

. . . THEIR QUALITY SHOWS UP IN SERVICE

IN an alloy steel, quality is but another term for utility. For by quality we mean not only that the steel must measure up to specific and predetermined requirements—must have definite physical, metallurgical and chemical properties—but that it must be *consistently uniform* in those properties from bar to bar, from heat to heat, from shipment to shipment.

This uniformity, this unvarying dependability which distinguishes Carnegie-Illinois Alloy Steels, we obtain through scientific control of every step in manufacture. For Carnegie-Illinois alloy mills are operated on the principle that quality in alloy steels demands the most exacting control of the mechanics of rolling, as well as the metallurgy of the steel itself.

From billet to shipping floor every step is subjected to rigid control and to relentless inspection. The result is an alloy bar free of physical defects or blemishes, straight as a die, finished to save costly operations in your own plant. We know of no mill practice more exacting or carrying greater assurance of quality steel.

• • •

CARNEGIE-ILLINOIS STEEL CORPORATION
Pittsburgh and Chicago

Pacific Coast Distributors: Columbia Steel Company
San Francisco

Export Distributors: United States Steel Products Company, New York

US STEEL

UNITED STATES STEEL

coupling boxes, driving wheel centers, etc.

1 2 3 4 - - 7 - -

USS—United States Steel Corp. subsidiaries, including American Sheet & Tin Plate Co., American Steel & Wire Co., Carnegie-Illinois Steel Corp., Columbia Steel Co., National Tube Co., Tennessee Coal, Iron & Railroad Co.

1 2 - - - - - - - -

Type 4/6 CR; carbon .15, manganese .60, phosphorus .03, sulphur .03, silicon .50, chromium 4 to 6.

Type 4/6 CR-MO; carbon .15, manganese .60, phosphorus .03, sulphur .03, silicon .50, chromium 4 to 6, molybdenum .40 to .65; this and the above type can also be furnished in .10, .20 and .25 carbon.

Type 4/6 CR-T; carbon .15, manganese .60, phosphorus .03, sulphur .03, silicon .50, chromium 4 to 6, titanium is five times the minimum carbon content.

Type 12; carbon .10, manganese .50, phosphorus .03, sulphur .03, silicon .50, chromium 11.50 to 14.

Type 17; carbon .10, manganese .50, phosphorus .03, sulphur .03, silicon .50, chromium 16 to 19.

Type 21; carbon .10, manganese .50, phosphorus .03, sulphur .03, silicon .50, chromium 20 to 24.

Type 27; carbon .10, manganese .50, phosphorus .03, sulphur .03, silicon .50, chromium 25 to 30.

Type 18-8; carbon .15, manganese .50, phosphorus .03, sulphur .03, silicon .75, chromium 17 to 20, nickel 8 to 12.

Type 18-8S; carbon .07, manganese .50, phosphorus .03, sulphur .03, silicon .75, chromium 17 to 20, nickel 8 to 12.

Type 18-8Mo; with 2 to 4 molybdenum.

Stabilized 18-8; carbon .12, titanium five times the minimum carbon content, remaining analysis similar to 18-8S; developed to provide a steel in which intergranular corrosion adjacent to welds is prevented.

Type 19-9; carbon .20, manganese .50, phosphorus .03, sulphur .03, silicon .75, chromium 18 min., nickel 8 min.

Type 20-10; carbon .20, manganese .50, phosphorus .03, sulphur .03, silicon .75, chromium 19 min., nickel 9 min.

Type 25-12; carbon .25, manganese 2, phosphorus .03, sulphur .03, silicon .75, chromium 22 to 28, nickel 12 to 16.

- 2 - 4 - - - - - -

Chrome-moly pipe steel; carbon 10 to 20, manganese .60 max., silicon .45 to .75, chromium 1.5 to 2, molybdenum .60 to .80.

Flange-bolt; carbon .35 to .45, manganese .40 to .60, silicon .45 to .75, chromium 1.5 to 2, molybdenum .60 to .80.

- - 3 - - - - - - -

Castings: Hadfield manganese steel No. 6; carbon 1 to 1.4, manganese 10 to 14. Chrome manganese No. 19; carbon 1 to 1.4, manganese 10 to 14, chromium 1. Chrome nickel moly No. 3; carbon .75 to .85, manganese .9 to 1, chromium 1.4 to 1.6, nickel .50 to .75, molybdenum .3 to .4, and others.

- - - 4 - - - - - -

Cor-Ten (See listing under C)

Man-Ten (See listing under M)

Sil-Ten (See listing under S)

Manganese chromium, Cromansil (See listing under C), S.A.E. and related heat treating steels.

- - - - - - - 7 - -

American Transformer 60, 66, 72 (Figures as hundredths indicate watt loss).

American Dynamo, Motor, Armature, etc.

For further information see ad on page 64-22D.

V

VANCORAM — Vanadium Corp. of America, 120 Broadway, New York. Ferro-alloys of vanadium, silicon, chromium and titanium; also special alloys and metals.

1 2 3 - - - - - - -

VASCO—Vanadium-Alloys Steel Co., Grant Bldg., Pittsburgh.

Stainless; a noncorrosive steel.

Vanadium tool steel; general utility tool steel in various carbon contents, particularly adapted to resist shock, strain and fatigue.

- - 3 - - - - - - -

VIBRALOY — Audubon Wire Cloth Corp., Custer Ave., Allen and Bath Sts., Philadelphia. Abrasion resisting alloy used in screens and wire cloth for handling sand, gravel, coke, crushed stone, etc.

W

- - 3 - - - - - 8 -

WANDO—Cyclops Steel Co., Titusville, Pa. Carbon .95, manganese 1.05, chromium .50, tungsten .50, vanadium .20; oil hardening steel; nondeforming.

X

- 2 - - - - - - - -

X-ITE—General Alloys Co., 367-405 W. First St., Boston. Nickel 37 to 40, chromium 17 to 21; for furnace parts not subjected to alternate heating and cooling cycles; standard material for commercial heat treating furnace parts.

Y

1 - - 4 5 - - - - -

YOLOY—Youngstown Sheet & Tube Co., Youngstown, O. Special service alloy steel of increased tensile strength and high ductility combined with corrosion resistance.

Z

1 - - 4 5 - - - - -

ZAMAK—New Jersey Zinc Co., 160 Front St., New York. Zinc alloys for die cast machine parts.

No. 2; aluminum 4.1, copper 2.7, magnesium .03, remainder Horse Head special zinc.

No. 3; aluminum 4.1, magnesium .04, remainder Horse Head special zinc.

No. 5; aluminum 4.1, copper 1, magnesium .03, remainder Horse Head special zinc.

No. 6; aluminum 4.1, copper 1.25, remainder Horse Head special zinc.

For further information see ad on page 76-34D.

1 - - 4 5 - - - - -

Z-METAL—Produced under metallurgical control of the Castings Corp., 666 Andrews Bldg., Buffalo, by foundries equipped with special heat treatment equipment; alloyed white iron having high physical characteristics; high ultimate strength and yield point, adequate ductility.

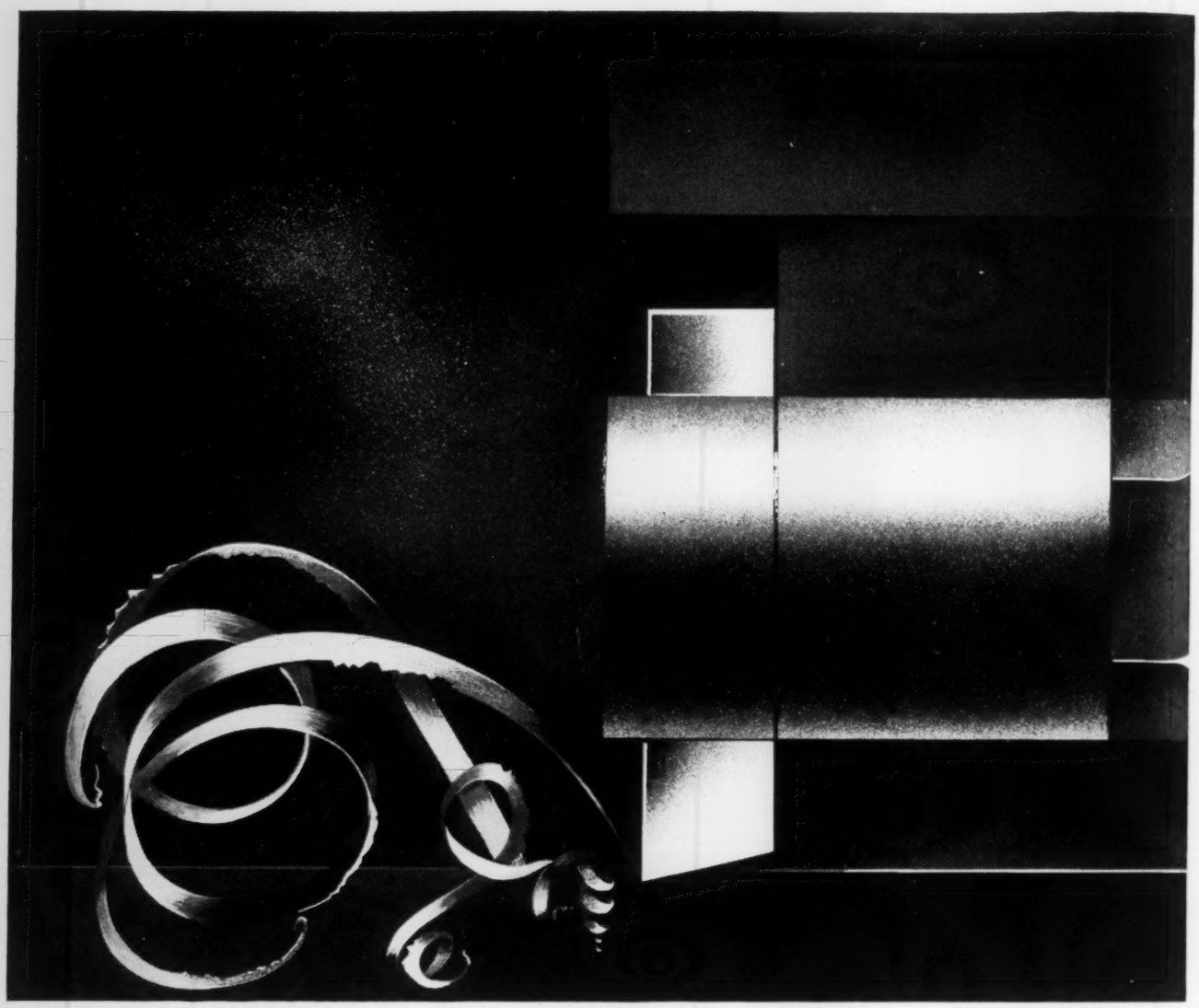
- 2 - - - - - - - -

ZORITE—Michiana Products Corp., Michigan City, Ind. Nickel 37, chromium 15 per cent.

1 - 3 4 - - - - - -

Z-RON—Gunite Foundries Corp., Rockford, Ill. Heat treated white iron (spheroidized); for underground bolts, hydraulic castings, gears, chain, connecting rods, and other machine parts.

1—Corrosion Resistant; 2—Heat Resistant; 3—Abrasion Resistant; 4—High Tensile Strength; 5—High Ductility; 6—Bearing Application; 7—Electrical Uses; 8—Heat Treating; 9—Low Specific Gravity



MOLY pares machining costs

MACHINE SHOP cost sheets often contain an accumulation of items that are avoidable. Some are caused by hold-overs from other processes — rolled-in scale — non-uniform hardness — distorted parts — meaning excessive tool, labor and material costs.

They are avoidable by standardizing on Molybdenum steels. Forgings are less likely to be scaly, seamed, or temper brittle. Carburized parts are less apt to be inconsistently distorted. High cutting speeds are safer and close tolerances more easily maintained. Time, power, labor, tool and material costs can be greatly reduced.

One maker of tool joints for oil-well service — a high-volume precision job — reports a 10% saving in over-all machine costs by standardizing on Chrome Moly steel (SAE 4140).

Your particular case may not be exactly similar, but — the savings in production costs effected by Moly steels and irons are not confined to the machine shop. So, it will pay you to investigate Moly in connection with your own problems. Our laboratory facilities are available if you are interested. Meantime our helpful technical book, "Molybdenum," is yours for the asking — as is also our periodically published news-sheet, "The Moly Matrix." Climax Molybdenum Company, 500 Fifth Avenue, New York.

CUTS COSTS CLIMAX Mo-lyb-den-um CREATES SALES

MOLY

Plastics and other Nonmetallic Materials

A

ACE—American Hard Rubber Co., 11 Mercer St., New York. Hard rubber, resistant to most acid and alkali solutions and fumes. Tensile strength 6500 to 9000 pounds per square inch; compressive 10,000 to 12,000. High electrical insulating values at low and high voltages and frequencies. Excellent thermal insulating qualities. Nonflammable; readily molded or machined. Physical and mechanical properties may be varied. For automotive and X-ray equipment, refrigerators, textile, chemical, electrical, printing and mining machinery, etc.

ACITHERM—United States Stoneware Co., 50 Church St., New York. Heat and acid resisting ceramic material employed in machines such as pumps and exhausters to overcome corrosion, high heat and wide thermal shocks. Extremely hard with high compressive strength.

ACRYLOID—Resinous Products & Chemical Co., 222 West Washington Square, Philadelphia. Polymerized, acrylic acid ester. Flexible. Specific gravity 1.18. Water white, non-yellowing. Resistant to water, oils, acids and alkalies. Supplied in solutions and as a molding powder.

AERTITE—Johns-Manville, 22 E. Fortieth St., New York. A tough rubbery asphaltic-asbestos coating in plastic form. Used on mechanical equipment to prevent air infiltration.

AETNA—Aetna Rubber Co., 815 East Seventy-ninth St., Cleveland. Hard rubber high in tensile strength and elongation. Unusually low in specific gravity. Used for storage battery containers, vent caps, covers, racks, nuts. Rods and sheets available.

AJAX—Vulcanized Rubber Co., 261 Fifth Ave., New York. A hard rubber that resists the corrosive action of chemicals such as acids and alkali solutions and withstands moisture. Electrical properties include high insulating values, exceptional at both low and high voltages and frequencies. Readily molded and machines easily to desired shapes and designs. Characteristics render the material suitable for handles, bushings and other machine parts to specification.

AMEROID—American Plastics Corp., 50 Union Square, New York. Nonflammable casein composition material in the form of fully cured and hardened sheets and rods. Not moldable. Used for small knobs, handles, etc. Rod stock is employed in various types of small electrical apparatus.

ARCOLITE—Consolidated Molded Products Corp., Scranton, Pa. Phenol-formaldehyde molding material. High dielectric and a tensile strength of 6500 pounds per square inch. Parts come from the mold hard, with clear polished finish. May be molded around or over metal or wood cores in parts requiring greater strength and rigidity. Can be drilled, tapped or machined, or threads may be molded-in accurately. Resistant to water and other solvents. In any color, plain or mottled. For machine frames and other components, electrical parts, etc.

ARMITE—Spaulding Fibre Co. Inc., Tonawanda, N. Y. A thin insulation (fish paper) for electrical and mechanical uses. Strong and tough. Applications include motor slot insulation, coil form liners, switch box liners, radio insulation, automotive starter slot and generator slot insulation, electric toy insulation, etc.

Additions to listings:

B

BAKELITE—Bakelite Corp., 247 Park Ave., New York. Phenol resinoid having high dielectric and mechanical strength, resistance to heat, moisture, alkalies and most acids. In laminated form for bearings, gears, pump valves, rollers and washers, vibration-absorbing machine mountings, etc. The molded form is adaptable to such applications as magneto cases, pulley wheels, lathe handwheels, control buttons, spinning buckets, insulation parts, etc. Transparent cast resinoids fulfill mechanical requirements as gear handles, levers and knobs, gages and dials.

BANNER—American Hard Rubber Co., 11 Mercer St., New York. A black hard rubber of fair lustre, with a tensile strength of 4000 to 7000 pounds per square inch; compressive strength 10,000 to 11,000. In rods, tubes and sheets. Recommended where finish or delicate machining operations are not of utmost importance. Natural black color or in green, blue, red, violet, brown and gray, and mottled colors of various combinations. Molded applications cover wide range of machine parts.

BEETLE—Beetleware Div. of American Cyanamid Co., 30 Rockefeller Plaza, New York. Urea-formaldehyde molding powder. Natural color is a translucent ivory, permitting easy pigmentation to attain any desired shade. Available in whites and pastel tints as well as in a complete range of solid colors. After fusing to desired shape, it cannot be softened subsequently by heat and pressure to be reshaped, but remains rigid and durable. Electric clock cases, auto knobs and handles, electric vibrator handles, fruit juice reamers and extractors, bowls, etc., are some of its uses.

BOOTH FELT—The Booth Felt Co. Inc., 444 Nineteenth St., Brooklyn, N. Y. Precision cut felt in a variety of types and grades. Uses include washers, gaskets, grease seals, pads for insulating machinery in the elimination of noise and vibration, as well as numerous other applications in machine design.

For further information see ad on page 70-28D.

Additions to listings:

C

CATALIN—American Catalin Corp., One Park Ave., New York. A cast phenolic resin, available in rods, sheets, tubes or special castings. Nonflammable, absorbs almost no moisture, resists alcohol, oils and most common acids. Has high dielectric, tensile and compressive strength; works freely, similarly to brass or hard wood. Furnished in a variety of basic colors, opaque, translucent and transparent, in either plain colors or with mottled or grained effects. Applications include clock and instrument cases, auto fittings, knobs for electrical appliances and other machine parts.

CELLANITE—Continental-Diamond Fibre Co., Newark, Del. Laminated nonphenolic synthetic resinous insulating material. Odor repellant, has high electrical and thermal insulating properties combined with structural strength. Adaptable to all machining operations. Widely used for frost breaker strips on refrigerator cabinets.

CELITE—Johns-Manville, 22 E. Fortieth St., New York. Diatomaceous silica in powdered, granular and brick forms used for insulation of high temperature equipment.

CEL-O-GLASS—E. I. duPont de Nemours & Co., Wilmington, Del. A glass substitute with a wire mesh base. Shatterproof and extremely light in weight. Applicable where a translucent flexible material is required.

CELORON — Continental-Diamond Fibre Co., Newark, Del. Manufactured by impregnating sheets of woven fabric such as cotton duck or linen with synthetic resin, superimposing one sheet upon another until required thickness is attained. Entire mass then is subjected

There is a

TOLEDO ALLOY

for every need

TOLEDO ALLOY No. 3—A carburizing steel, a modified analysis of the popular No. 4615 carburizing steel heat-treated to give uniformly good machinability and uniform grain. Excellent results obtained with short cycle carburizing treatment generally associated with No. 4615.

TOLEDO ALLOY No. 4—An abrasive resistant silicon molybdenum steel with excellent hardening properties. Its use is paramount for mining tools, wear-plates, crusher-plates and pinions of various kinds.

TOLEDO ALLOY No. 6—An air-hardening die steel of uniform machining qualities. Gives very long life under severe wear and heat.

TOLEDO ALLOY No. 7—A triple heat-treated carbon vanadium steel which has found many applications in the railroad and locomotive industry, where there is great and repeated stress.

TOLEDO ALLOY No. 8—A pearlitic manganese steel with the analysis adjusted to give high tensile strength and exceptional ductility. Since its inception it has found many and diversified uses — automotive, automotive accessories, aircraft building, machinery, and other uses where these particular properties are advantageous.

This signature identifies Toledo Alloy Castings **A**

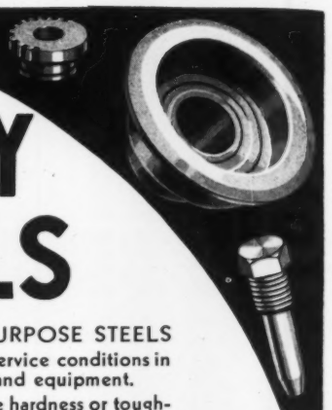
The

INDUSTRIAL STEEL CASTING CO.

ELECTRIC STEEL CASTINGS

Toledo Ohio

ALLOY STEELS



AND SPECIAL-PURPOSE STEELS

for meeting unusual service conditions in designing machinery and equipment.

Parts requiring extreme hardness or toughness, resistance to wear or metal fatigue, minimum distortion after heat treatment, larger factor of safety without increased weight, can be made to better advantage with B & L Cold Finished Alloy Steels.

Your inquiries invited on special problems.

BETTER MADE STEELS LABORATORY TESTED

BLISS & LAUGHLIN, INC.

HARVEY, ILL. BUFFALO, N.Y.

Sales Offices in all Principal Cities

ACKNOWLEDGMENT

Machine Design takes this opportunity of thanking all those companies and individuals who co-operated in the compilation of this directory of engineering materials. We are particularly grateful to the manufacturers of the materials for their response to requests for information on their products, and to the advertisers whose collaboration made possible the presentation.

◆

to pressure and heat in a press. Impervious to temperature changes, oil and water, and is not affected by oxidation. Grade C (canvas base) for heavy duty spur, helical, bevel or worm gears. Has high impact strength and shock absorbing properties. Type L (linen base) for small gears of fine pitch and narrow face.

CETEC—General Electric Co., Plastics Dept., West Lynn, Mass. Cold molded plastic molded to shape at room temperture and then heat treated for strength, toughness. Two general types: Non-refractory, containing organic ingredients such as asphalt as a binder, with asbestos as filler; and refractory containing inorganic ingredients such as cement and drying oils as a binder with an asbestos filler. Properties include mechanical strength, rigidity, resistance to high temperatures. Adaptable to moderately complicated shapes. Not recommended for parts requiring high dielectric strength or thin sections.

CODITE — Continental-Diamond Fibre Co., Newark, Del. Distinguished from vulcanized fiber by its greater flexibility, plasticity, higher electrical insulating properties and greater mechanical strength. Hard, tough, somewhat translucent and thermoplastic. Machines easily and takes high polish. Tubes may be expanded in diameter or spun or pressed in a heated die. Extruded washers have been fabricated with a shank measuring 0.070-inch and a flange of only 0.023-inch.

COLASTA No. 56—Specialty Insulation Mfg. Co. Inc., Hoosick Falls, N. Y. Special resin material with small percentage of rubber; developed for aircraft magneto applications; highly resistant to carbon tracking; absorbs practically no moisture and is impervious to oil and weak acids.

CORINCO—Cork Insulation Co. Inc., 155 East Forty-fourth St., New York. Isolation corkboard for control of noise and vibration in machinery; proper density to withstand machinery loads.

CORPRENE—Armstrong Cork Products Co., Lancaster, Pa. A combination of cork and DuPrene, giving a highly oil resistant and compressible material. When the surface is sanded a high coefficient of friction is presented by the exposed surface, this characteristic being of advantage in making feed and friction rolls for handling oily or greasy materials. Other uses include poppet valve disks, valve packing, gaskets, etc.

Additions to listings:

D

DIAMOND — Continental-Diamond Fibre Co., Newark, Del. Vulcanized fiber Hard, dense, bone-like material that is tough, pliable and strong. Physical strength, high dielectric strength and adaptability to machining make it a universal raw material. In various forms such as insulation made in sheets and continuous rolls; flexible fiber for washers and gaskets; sheets, rods and tubes. Insulating members, gears, bobbin heads, etc., are fabricated. It may be turned, sawed, sheared or punched.

DILECTO — Continental-Diamond Fibre Co., Newark, Del. Laminated synthetic resinous material, waterproof and possesses great mechanical strength and adaptability to machining operations. Supplied with either mirror-like surface or dull satin finish, in two standard colors, a lustrous black and natural, which varies from a golden to a deep brown. Also furnished in pastel shades, natural wood grains and in modernistic designs. In three primal forms, sheets, rods and tubes. Uses include silent gears, for which graphite dilecto is used where lubrication is difficult or likely to be overlooked. Also used for thrust washers, bearings and bushings.

DUFELT—Felters Co. Inc., 210 South St., Boston. Felt in the form of laminated washers for oil and grease retainment. This company also produces felt in numerous other forms and shapes to provide resiliency, isolate sound, absorb vibration and shock, and to insulate from heat or cold. Other industrial uses of the material include covers for polishing rolls, wicks for the lubrication of bearings, dustproofing, filtering, etc.

DUPRENE—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Synthetic rubber resistant to oil, heat and oxidation.

DUREZ— General Plastics Inc., North Tonowanda, N. Y. Phenolic resinoid molding compound with high dielectric strength. Possesses permanent wear-proof finish which withstands scuffing, etc. Adaptable to the use of metal inserts to insure complete rigidity. Particularly suitable for applications requiring close tolerances in molding, and where moisture resistance is necessary to prevent changes in dimensions. Furnished in wide range of colors. Machine parts for which this plastic is used include foot treadles, business machine parts, electrode panels, parts for motors, ignition devices, machine housings, corrosion and friction resistant parts, etc.

For further information see ad on page 60-18D.

DURITE—Durite Plastics, Div. of Stokes & Smith Co., 5016 Summerdale Ave., Philadelphia. Phenol - formaldehyde, phenol-furfural synthetic resinous materials including pure resins in dry, liquid or varnish forms, hot press molding powders, laminating varnishes, etc. Chemical, electrical and mechanical characteristics can be varied. For molding a variety of machine parts.

Additions to listings:

E

EBROCK—Richardson Co., Melrose Park, Ill. An acid resisting plastic for specific requirements including such parts as battery containers.

For further information see ad on page 77-35D.

EEL-SLIP—Johns-Manville, 22 E. Fortieth St., New York. A compound of asbestos fiber, graphite and rubber. Has high tensile strength and is heat resistant. For bearings, suction box covers, etc.

Additions to listings:

F

FIBERLOID—Fiberloid Corp., Indian Orchard, Mass. A cellulose nitrate plastic furnished in sheet, rod and tube form. Can be fabricated by molding, turning or machining into any desired shape.

FIBERLON—Fiberloid Corp., Indian Orchard, Mass. Nonflammable cast phenolic resin, available in sheets, rods and tubes, or cast to special shape. Furnished in a wide variety of colors, transparent or opaque. Can be machined, turned or polished.

FIBESTOS—Fiberloid Corp., Indian Orchard, Mass. Slow burning cellulose acetate material, flexible and adaptable to any contour or shape. In a wide variety of colors and not affected by ultra-violet rays of the sun. Sheets, rods and tubes.

FORMICA—Formica Insulation Co., 4614 Spring Grove Ave., Cincinnati. Combines with its insulating qualities and high dielectric strength, a high degree of mechanical strength and low moisture absorption. Tensile strength is slightly lower than cast iron but much more elastic, adapting it to use for gears that are quiet and durable. Absorbs no oil and changes in dimensions only slightly as the result of moisture absorption. Used for insulating washers and bushings, punched insulating parts in switches, automotive starting systems, radio apparatus, X-ray equipment, etc.

FYBEROID—Wilmington Fibre Specialty Co., Wilmington, Del. High grade insulating paper in sheets, rolls, coils, and fabricated in special parts. Used in the manufacture of motors, dynamos, magnetoes, electric railway equipment, and other electrical machinery.

For further information see ad on page 72-30D.

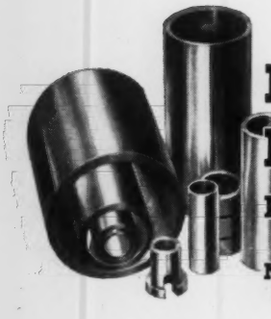
Additions to listings:

G

GRAPHIC LAMICOID—Mica Insulator Co., 200 Varick St., New York. A new product that incorporates designs, colors, printed matter, diagrams, charts and reproductions into permanent panels or sheets. The finished material has the general mechanical and electrical qualities of laminated synthetic resinoid products. Printing or design cannot be removed or erased. Made in opaque and translucent sheets, the latter being adaptable for indirect or rear illumination.

GUMMON—Garfield Mfg. Co., Garfield, N. J. Black in color and capable of taking high polish. Has a continuous heat resistance of 400 degrees Fahr. Inert chemically and unaffected by boiling water; impervious to ordinary chemicals with the exception of the stronger acids; resists hot oil and will not shrink, crack, warp, or deteriorate with age. For insulated parts such as wiring devices and other small units.

Additions to listings:



BRONZE BEARINGS

BUSHINGS AND PARTS FOR ALL MECHANICAL APPLICATIONS

BRONZE BEARINGS AND BUSHINGS
Made to blue print. Patterns and tools for over 30,000 designs placed free at the disposal of our customer. Engineering and metallurgical counsel without cost or obligation.

STANDARDIZED BRONZE BEARINGS
Hundreds of sizes and types of completely machined and finished bronze bushings and bearings for all conceivable applications constantly carried in stock. Write for catalog.

PRECISION BRONZE BEARINGS
Diamond bored to close limits for applications where machining in place is not desired.

GRAPHITED OIL-LESS BRONZE BEARINGS
For all applications where the product restricts the use of lubricants.

SPECIAL DESIGNS AND ALLOYS
Our completely staffed engineering, metallurgical and research departments serve without cost or obligation all who desire aid in determining the most suitable bearing designs and alloys for special applications.

HIGH-LEAD BRONZES
Special low-friction alloys for engine, compressor, pump and other bearing applications.

ELECTRIC MOTOR BEARINGS
Standard sizes for all makes of electric motors.

BRONZE THRUST WASHERS
Made from carefully controlled alloys to customer's specifications.

BRONZE CASTINGS
Plain and finished. Alloyed to customer's requirements.

BABBITT-LINED BRONZE-BACKED BEARINGS
Made to blue print for specific requirements.

BRONZE BARS CORED AND SOLID
Machined and centered, cast in 13-inch lengths. 121 sizes in stock. Available from all leading mill supply dealers.

BUNTING INDUSTRIAL BABBITT
A new and superior general purpose metal. Sold by all leading mill supply dealers.

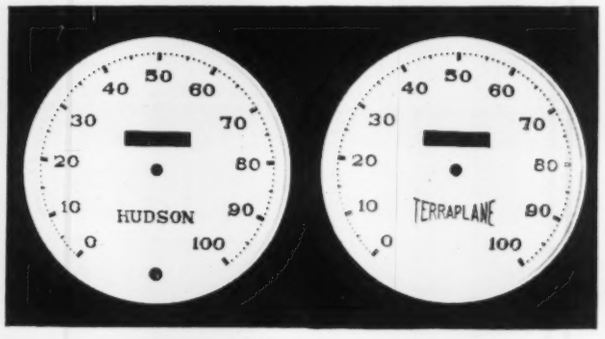
THE BUNTING BRASS & BRONZE COMPANY
The Largest Manufacturers of Bronze Bearings and Bushings in the World
TOLEDO, OHIO
Branches in All Principal Cities

BUNTING Quality
PHOSPHOR BRONZE
BUSHINGS • BEARINGS
MACHINED AND CENTERED BRONZE BARS

Write for it . . .

● YOUR SAMPLE FILE of the standard types of felt—bound into a chart classifying applications of each type! Designed to be useful to all users of felt—not for sales follow-up. Mailed without charge.

Booth
PRECISION CUT FELT
BOOTH FELT COMPANY, INC. 444—19TH ST., BROOKLYN, N. Y.



TRANSLUCENT PLASTICS

These speedometer dials, produced for Stewart-Warner Corporation, illustrate both the beauty and practical value of translucent plastics. Their handsome appearance harmonizes completely with the modern motor car interior. Day or night, they can be read at a glance; yet when they are illuminated from behind, the light is so softly diffused that there is not the slightest glare in the eyes of the driver.

Stewart-Warner Corporation is still another of the nationally known manufacturers who have found here the engineering knowledge and production facilities to handle their most exacting molding jobs. May we suggest that you, too, will find it advantageous to consult us regarding your plastic molding problems?

CHICAGO MOLDED PRODUCTS
CORPORATION
2147 Walnut Street *Chicago, Ill.*

H

HARVITE — Siemon Co., Bridgeport, Conn. Available in a variety of colors and can be molded into various shapes. Good electric insulator and will withstand temperatures up to 190 degrees Fahr. For electrical insulators, push-buttons, socket keys, handles, etc.

HAVEG—Haveg Corp., Newark, Del. Construction material molded from asbestos and phenol-formaldehyde resin; has high acid resisting properties, low heat conductivity and does not chip or fracture easily.

HAVEGIT—Haveg Corp., Newark, Del. Acid resisting cement based on phenol formaldehyde resin and fillers, hardened at room temperature by action of alcoholic solution of sulphuric acid; acid resisting properties same as Haveg; used in setting up brick and tile linings in chemical equipment.

HEMIT—Garfield Mfg. Co., Garfield, N. J. Gray-white in color and has a heat resistance ranging from 1100 to 1500 degrees Fahr. For interior parts of heating devices such as arc shields or where a molded part must withstand an arc. Also furnished impregnated for moisture resistance.

Additions to listings:

I

INDUR—Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis. A group of plastic materials comprising insulating varnish, molding powder and molding resins. Properties variable according to the application for which they are intended. For parts, instruments and other machine accessories including insulating panels, knobs and handles.

INSULKOTE—Johns-Manville, 22 E. Fortieth St., New York. Weatherproof coating for use over insulation of ducts and other exposed equipment.

INSUROK — Richardson Co., Melrose Park, Ill. A laminated phenolic product in sheets, rods, tubes, gear blanks, bearings and fabricated parts in several grades for different applications. Has toughness, heat resistance, low water absorption, high dielectric strength, resilience, lightness and workability. Noncorrosive, not affected by age, resists most re-agents, acids, solvents, oils, etc.
For further information see ad on page 77-35D.

Additions to listings:

K

KASOLOID—Synthetic Plastics Co., One St. Francis St., Newark, N. J. A thermoplastic manufactured from casein. Will withstand acids, alkalies, oils and solvents. Slightly hygroscopic, therefore unfit for anything where accurate dimensions are important. Used especially where small objects of brilliant color and high luster are desired. Natural color is blond.

KOMPO-KORK—Korfund Co. Inc., 48-15 Thirty-second Place, Long Island City, N. Y. Plates of finely granulated compressed cork with an oxidized linseed oil binder and a burlap backing. Adaptable where irregularly shaped plates are required for isolating light machinery to combat vibration.

KORFUND—Korfund Co. Inc., 48-15 Thirty-second Place, Long Island City, N. Y. A resilient mat of pure natural cork steel bound and treated with an oil. Unaffected by water, acids and temperature changes. Used as bases for machines to isolate intense vibration. Another isolator developed by the company is identical in construction except that it is bound with asphalt and asphalt felt. In addition a side isolator applied with mastic or hot asphalt to side walls is available.

KORK RUBBER—Korfund Co. Inc., 48-15 Thirty-second place, Long Island City, New York. Plates of finely granulated cork and rubber particles compressed together. Adaptable for vibration insolation of light machine bases.

KOROSEAL—B. F. Goodrich Co., Akron, O. Synthetic rubber-like material made in various consistencies from jelly to bone-like hardness. Jelly is sold for making molds for plastic casts, but other compounds sold only as finished products and not available for processing. Superior to rubber in resistance to corrosion, light, flexing, oxidation and penetration of moisture or gases. Odorless and produced in a variety of colors. Does not swell in oil. Made in molded and extruded forms; also applied as coating to paper and fabric.

Additions to listings:

L

LACANITE—Consolidated Molded Products Corp., Scranton, Pa. Molding compound with high dielectric strength, does not absorb moisture, and withstands heat up to 150 degrees. Exceptional tensile strength and takes all finishes. In all colors, including white, and available for a wide range of uses.

LAMICOID — Mica Insulator Co., 200 Varick St., New York. Standard sheet stock in various grades including punching stock with paper base. Not affected by dilute acids or oils. Recommended where stiffness, good electrical properties, surface resistivity, etc., are concerned. Also flexible grade punching stock, as well as a general purpose paper base stock. The linen stock is used for fine machine work such as small tooth gears and pinions. Supplied also in tubing and rod form, washers, disks, gear blanks and pump valves. Lamicoid decorative sheets and bonded metal, which is a combination of steel and plastic material, are finding wide application in air conditioning cabinets, slot machines, refrigerator cabinets, etc. Translucent Lamicoid in ivory-white and tan, or in other specified colors, is available.

LIGNOTITE—Lignotite Co., 2727 Archer Ave., Chicago. Plastic material in powder form for hot hydraulic press molding. Extremely tough with high mechanical and dielectric strength. Resistant to oil, water, heat and most chemicals. Basis in casein to which are added certain solvents, fillers and the necessary coloring matters.

LUMARITH—Celluloid Corp., 10 E. Fortieth St., New York. Cellulose acetate nonflammable material. Flexible and adaptable to any contour or shape. Permanently retains color. In sheets, rods, tubes, rolls and molding powders.

Additions to listings:

M

MAKALOT—Makalot Corp., 262 Washington St., Boston. Synthetic resins, varnishes, cements and molding powders. Various grades and types are available to fill a wide range of uses which include automotive and radio parts. Flowing and covering qualities of these resins eliminate sticking troubles. For complicated articles where high strength and shock resistance are considerations.

MARBLETTE—Marblette Corp., 37-21 Thirtieth St., Long Island City, N. Y. A cast phenolic resin now used commercially for parts requiring machining. These cast synthetic resins are somewhat softer than molded materials and can be easily turned, drilled, sawed, threaded, carved and highly finished by polishing.

MICABOND—Continental-Diamond Fibre Co., Newark, Del. Resistant to heat, high in dielectric strength, easy to machine or form to shape. Supplied in molding plate, segment plate, heater plate, flexible sheets, tape, tubing and in punched and formed parts such as V-rings, washers, segments and other special shapes.

MICARTA — Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. A laminated resinous material formed by action of heat and pressure on a number of layers of paper or fabric which has been impregnated with a synthetic resin. Properties include strength, resilience, light weight, long life, resistance to heat, corrosion, excellent electrical insulating properties, and good machining and punching characteristics. Mechanical uses include gears, compressor rings, bearings, pump valves and piston rings, and numerous electrical applications.

MICOID—Mica Insulator Co., 200 Varick St., New York. Homogeneous bakelite sheet that is not laminated. Has good electrical and mechanical qualities and is available in all thicknesses, in black or brown color.

Additions to listings:

N

NATIONAL—National Vulcanized Fibre Co., Wilmington, Del. Vulcanized fiber, a tough, resilient material possessing high mechanical strength and dielectric properties. Produced by chemically treating cotton cellulose. Made

Design for Wear Resistance

AMPCO

"THE METAL WITHOUT EQUAL"

is now used by over fifty nationally-known machinery manufacturers for parts of the machines they build where resistance to wear is essential.

AMPCO Metal is used for such bronze parts as worm wheels, spur, spiral, bevel gears, feed and traveling nuts and all other parts where resistance to wear and squashing out is found necessary.

Over the past ten years the demand for centrifugal castings has increased greatly and AMPCO Metal, Inc., is one of the few foundries equipped for this type of production. Our Engineering Department will help you with design problems.

Let us tell you what AMPCO Metal can do for you. Send for "Ampco Metal—Its Uses in Modern Industry."

AMPCO METAL, INC.

MILWAUKEE, WISCONSIN

OFFICES IN PRINCIPAL CITIES

WE venture to say that, could we personally consult with you on the design of your new products, we could show you, in most cases, how Wilmington Fibre would give you *better parts, at less cost.*

However, since we can't "sit in", unless consulted specifically, we have prepared a 32-page treatise on fibre and fibre fabrication, which we offer to you as an aid in determining possible uses and advantages of fibre for your product. A copy will be sent you without obligation. Write today.

"Wilmington Fibre"

WILMINGTON FIBRE SPECIALTY COMPANY

PIONEERS IN FIBRE FABRICATION — *WILMINGTON, DELAWARE*

Engineers, Designers and Welding Users

AVOID COSTLY MISTAKES

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Find the Right Answer to All Welding Problems in the New

Procedure Handbook of Arc Welding Design and Practice

586 Pages—Over 700 Illustrations, including 143 Pages of Important New Data

• Procedure Handbook is the most valuable work of its kind ever published. Recognized everywhere as the authority on electric welding. Used by prominent engineering schools and thousands of industrial plants in the U. S. and foreign countries.

New edition contains complete and accurate data on all latest arc welding applications and design procedures—everything you need to know for most efficient use of arc welding.

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• *Printed on fine paper with semi-flexible binding of simulated leather, gold embossed; size 6 x 9 inches.*

POSTPAID

in two primary forms, sheets and tubes, from which all other shapes are made. Two principal grades, hard fiber for electrical and mechanical purposes, and flexible fiber for valves, gaskets, packing and washers. This material is to a considerable extent plastic, especially when heated, and may be pressed into many simple shapes.

NATIONAL CARBON—National Carbon Co. Inc., P. O. Box 6087, Cleveland. Carbon and graphite in amorphous or graphitic form. Can be manufactured in a variety of shapes, molded, extruded or machined to meet specific requirements. In graphitic form carbon possesses excellent lubricating properties. Carbon is highly resistant to most acids, alkalies and solvents. Used for sleeve bearings, packings, threaded parts, contacts, nozzles for corrosive liquids, etc. Carbon also is a good conductor of electricity.

NEILLITE—Watertown Mfg. Co., Watertown, Conn. Phenolic molding material for mechanical and electrical purposes.

NIGRUM—Bound Brook Oil-less Bearings Co., Bound Brook, N. J. Impregnated wood bushings, bearings and washers.

Additions to listings:

O

O-I GLASS WOOL—Owens-Illinois Glass Co., Newark, O. Glass in fibrous form for insulating purposes. It is a downy snow white material marketed in packs cut to size. Placed between walls, it forms an enveloping blanket of protective material that is fire, moisture and vermin proof. Refrigerating cabinets is a typical use. Glass filters made of the same material also are being employed extensively in air conditioning equipment.

OHMOID—Wilmington Fibre Specialty Co., Wilmington, Del. A laminated phenolic insulation in paper, canvas and linen bases in sheets, rods and tubes, as well as fabricated special shapes such as stampings, bushings, washers, gear blanks, etc.
For further information see ad on page 72-30D.

Additions to listings:

P

PHENOLIC—Consolidated Molded Products Corp., Scranton, Pa. Has unusual tensile strength and takes high polish, satin or dull finish. Resistant to heat and is waterproof. In all colors except white, and also to match various wood finishes and mottling.

PHENOLITE—National Vulcanized Fibre Co., Wilmington, Del. Laminated bakelite that is practically impervious to moisture. Made by impregnating fibrous material such as paper, cotton and linen with Bakelite resin. Colors are black and natural (light brown); other colors available. In sheets, tubes and rods. Electrical properties much higher than vulcanized fiber. Can be sawed, turned, drilled, threaded and otherwise machined. Unlimited electrical applications. Mechanically, it is suitable for silent gears and pinions, bushings, bearings, valve, disks, etc.

PLASKON—Plaskon Co. Inc., 2110 Sylvan Ave., Toledo, O. A urea-formaldehyde molding material possessing strength, lightness of weight and translucency. Made in innumerable colors. Tensile strength is rated at 10,000 to 13,000 and compressive strength 25,000 to 30,000 pounds per square inch. Unaffected by alcohol, acetone, oils, gasoline or other common organic solvents. Used for a wide variety of machine parts in the radio, clock, scale, automotive and similar fields.
For further information see ad on page 78-36D.

PLASTACELE—DuPont Viscoloid Co. Inc., 350 Fifth Ave., New York. Made from celluloid acetate, in sheets, rods and tubes.

PLEXIGLAS—Rohm & Haas Co. Inc., 222 West Washington Square, Philadelphia. Polymerized, acrylic acid ester. Flexible. Specific gravity 1.18. Water white, nonyellowing. Resistant to water, oils, acids and alkalies. Supplied in sheets and as a molding powder.

PLIOFORM—Goodyear Tire & Rubber Co., Akron, O. Molding resin that is a synthetic derivative of natural rubber. Resists moisture and chemical corrosion. Hard, tough and readily molded by the application of heat without the use of sulphur or sulphur-bearing ingredients. In addition to its mechanical properties, it has good electrical characteristics. Available in two grades.

POLAROID—Land-Wheelwright Laboratories Inc., 168 Dartmouth St., Boston. Light-polarizing glass, possibilities of which include use in strain testers for engineering structures, three-dimensional motion picture apparatus, glareless auto headlights, etc.

PRYSTAL—American Catalin Corp., One Park Ave., New York. A water-clear cast phenolic resin having all the characteristics of "Catalin" but in addition, a much higher refractory index. In many cases it is used to replace glass. The material itself is nonflammable, highly acid resistant, absorbs almost no moisture and has high dielectric strength.

PYRALIN—DuPont Viscoloid Co. Inc., 350 Fifth Ave., New York. A proxylin plastic available in sheets, rods and tubes.

PYREX—Corning Glass Works, Corning, N. Y. Tradename covering borosilicate and other glasses of high thermal shock and chemical resistant characteristics. Available in a wide variety of shapes and in standard lengths of piping, tubing, cylinders, small sheets, and as numerous specialties.

PYROFLEX—Maurice A. Knight, Kelly Ave., Akron, O. Depolymerized colloidal resin compounded to obtain definite physical properties. This thermoplastic material is applied by dipping or in sheet form to protect surfaces of almost any size or shape from corrosion. Good dielectric properties and is a good bonding material where temperatures are not too high. Also serves as a vibration dampener.

PYROPLAX—Cutler-Hammer Inc., 1333 West St. Paul Ave., Milwaukee. Cold molded fireproof material. Binder and filler are inorganic, the former being a cement-like substance. The filler is a combination of asbestos and other inert ingredients. Gray white in color and has good finish. Capable of withstanding constant temperatures of 1000 degrees Fahr. Principal applications embody such parts as toaster stove resistance supports, switch and rheostat bases, magnetic switch blowout shields and switch barriers.

Additions to listings:

R

RESINOX—Resinox Corp., 230 Park Ave., New York. These molding resins and powders are improved thermosetting plastics having unusual plasticity with freedom from flow marks. They are available in a wide range of standard colors and pastel tints, and are water and alcohol proof, resistant to boiling water and dilute acids and alkalies. High torque and transverse strength and resistant to heat. Used in the manufacture of electrical and mechanical parts. Molding powders are available in non-bleeding and odorless form.

RESOGLAZ—Advance Solvents & Chemical Corp., 245 Fifth Ave., New York. This molding material is transparent, shock resistant, can be hot molded and does not cure. Resists water, dilute alkalies and acids, but is affected by oils.

REVOLITE—Bakelite Corp., 247 Park Ave., New York. A laminated cloth, paper or foil having such properties as waterproofness, resistance to light oils, gases and weak acids. Used for cable wrappings, endless belts and other types of belting, diaphragms for pumps and valves, gaskets, flexible connections for pulverizers and machinery where powder is handled, and roller coverings for machinery.

RICHELAIN—Richardson Co., Melrose Park, Ill. Urea-formaldehyde in choice of pleasing, nonfading colors, molded into articles as varied as toys, auto fittings, radio cabinets, electrical fixtures, etc. Has a high resistance to solvents, acids, oils, heat and is noncombustible.
For further information see ad on page 77-35D.

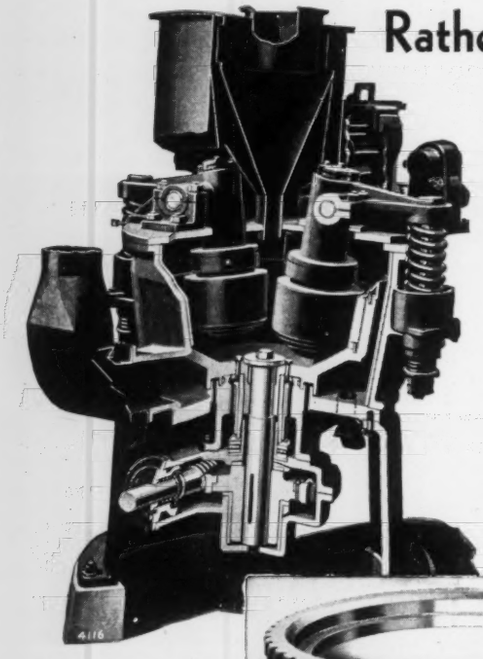
ROBERTSON FELT BONDED METAL—H. H. Robertson Co., Grant Bldg., Pittsburgh, and Felters Co. Inc., 210 South St., Boston. This material is produced by a process that effects a permanent bond between felt and metal. Application of felt may be on one or both sides of the metal, while the thickness of both felt and metal can be bent or shaped without destroying the bond.

RONYX—Resinox Corp., 230 Park Ave., New York. A machinable plastic available in many different straight and mottled colors. Produces extremely high gloss when buffed.

RUBTEX—Richardson Co., Indianapolis. Molded hard rubber for all purposes.
For further information see ad on page 77-35D.

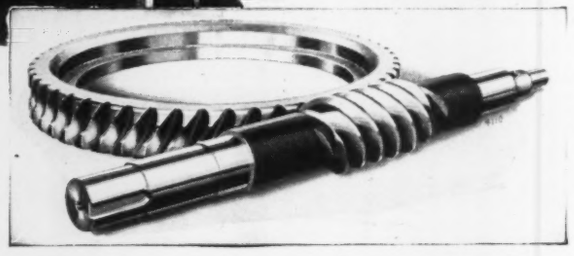
Additions to listings:

A GOOD DESIGNER *Uses Other Men's Brains*



Raymond Bowl Mill (Courtesy of Combustion Engineering Co. Inc.)

●



De Laval Worm and Gear Rim

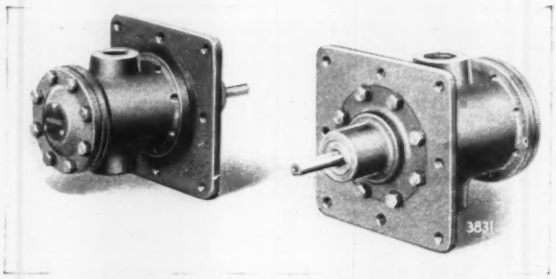
Rather than repeat the experimental development of transmission gears... *he selects*

DE LAVAL WORMS and GEARS

or complete De Laval Worm Reduction Units, including bearings and casings, thus drawing upon the wide experience and skilled judgment of men who have made gear design, gear manufacture and gear application a life-long study and business. By laying in gears in standard De Laval centers and using standard ratios he saves time and tool charges, while by using gear elements which have been manufactured from suitable heat treated alloys on a strict limit gage basis and tested out under the most severe conditions of practical service, replacements are eliminated and trouble-free operation is assured—in addition to which there is the maker's guarantee.

THE DE LAVAL-IMO *Rotary Displacement* PUMP FOR LUBRICATION

as here shown, has but two moving parts, a power rotor with extended shaft for connection to the driving shaft and an idler or sealing rotor meshing and synchronizing with the power rotor. There are no pilot gears and no separate bearings, and but one stuffing box. The discharge is continuous and without pulsation and no valves are required. Because of the high efficiency of the DE LAVAL-IMO pump, little power is consumed and there is less heating of the oil.



● Special flange mounting, as used for fuel and lubricating oil with Diesel engines.

DE LAVAL-IMO PUMPS

are supplied for pumping oil in all capacities and for pressures up to 500 lb. per sq. in. and above.

The pump can be coupled directly to an electric motor or a steam turbine, or to a shaft of any machine to which lubrication is supplied.

Our engineering corps will prepare special designs for exceptional conditions.

M-3

De Laval *Steam Turbine Co.*, Trenton, N.J.

Manufacturers of Steam Turbines, Centrifugal Pumps, Propeller Pumps, Rotary Displacement Pumps. Centrifugal Blowers and Compressors. Worm Gears, Helical Speed Reducing Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery. Sole Licensee of the Bauer-Wach Exhaust Turbine System.

S

SELFVULC — Self-Vulcanizing Rubber Co. Inc., 605 West Washington Blvd., Chicago. Rubber in both liquid and plastic form, vulcanizing itself when exposed to air; for protection against corrosion and abrasion; applied to pumps, blowers, turbine runners, screw conveyors and troughs, sand blasting cabinets, etc.

SPAULDING FIBRE—Spaulding Fibre Co. Inc., Tonawanda, N. Y. Light in weight, noncorrosive, has no electrolytic action on metals, is an insulator of heat and electricity, does not deteriorate with age and does not melt, soften or distort when subjected to heat under 200 degrees Fahr. Unaffected by oils, alcohol, benzol and other solvents. Available in sheets, tubes, rods, etc. Has a wide variety of mechanical applications.

SPAULDITE—Spaulding Fibre Co. Inc., Tonowanda, N. Y. Laminated phenolic material made with a base of rag paper, fine fabric or coarse canvas, the sheets being impregnated with varnish binders and subjected to high pressure under intense heat. Capable of withstanding extreme shocks and stresses. High tensile and compression strength. Resists most re-agents, acids, solvents, oils and other liquids. Available in flexible and rigid forms, in grade and thickness to meet a variety of mechanical applications. Wide range of colors and finishes.

SPRAYTEX—Monroe Auto Equipment Co., Monroe, Mich. An asphalt base material in which a soft filler is incorporated. Insulates against, and absorbs sound. This material is not affected by temperatures within the range of 30 degrees below zero to 250 degrees above. Supplied in liquid form and can be applied with spray gun equipment.

SYNTHANE—Synthane Corp., Oaks, Pa. Laminated bakelite sheets, rods, tubes, fabricated parts; silent stabilized gear material; panels, bushings, insulation, washers, corrosion resistant sheets and piping, vibration absorbing material, radio coil forms, dials, screw machine parts.

Additions to listings:

T

TEGIT—Garfield Mfg. Co., Garfield, N. J. Brown or black in color, polished if desired. Has heat resistance of 300 degrees Fahr. Inert chemically, unaffected by boiling water, impervious to ordinary chemicals with the exception of stronger acids, and resists hot oil. Will not shrink, crack, warp or deteriorate with age. Applications include wiring devices and other small insulated parts.

TENITE — Tennessee Eastman Corp., Kingsport, Tenn. A thermoplastic molding material made from cellulose acetate. High strength, uniform texture, stability, unusual machinability, smooth finish, high luster and wide color range are major characteristics. Supplied in molding sheet and granular form, and in any desired degree of flow. Available in plain and in variegated colors and in any degree of transparency. Is used for parts for business machines, refrigerators, electrical appliances, automobiles, etc.

TEXTOLITE — General Electric Co., Plastics Dept., West, Lynn, Mass. Laminated and molded plastics in grades to meet specific applications. Heat resistance, good electrical characteristics, glossy and smooth finish and excellent physical properties. The various classifications embody a variety of colors and combinations. Uses include such mechanical parts as gears, handles, knobs, supports, meter and instrument members, radio and automotive parts, etc.

THERMOPLAX — Cutler-Hammer Inc., 1333 West St. Paul Ave., Milwaukee. Composed of an organic binder made from carefully selected oil and pitches in conjunction with an inorganic filler such as asbestos. Will withstand continuous temperatures of 400 to 700 degrees Fahr., depending upon the formula used. It is a cold molded product, processed under high pressures varying from 500 to 140,000 pounds, depending on the size of the piece being molded. The part then is baked and a jet black or mahogany brown piece of good finish and high mechanical and electrical strength is obtained. A wide variety of intricate mechanical parts are produced from this material.

THIOKOL—Thiokol Corp., Yardville, N. J. Synthetic oilproof rubber in two types. Furnished in raw sheet form, corresponding to crude rubber. Material is processed like rubber and is characterized by its oil-resisting properties and ability to withstand corrosion. Typical applications include various types of hose for the distillate, paint and petroleum industries, gaskets, packing, pipeline rings, diaphragms, newspaper printing blankets, etc. Also "Thiokol" molding powder which requires only heat and pressure to form it into oilproof (soft) rubber-like objects.

TRANSITE—Johns-Manville, 22 E. Fortieth St., New York. Fireproof, corrosion-resistant material in a variety of forms as hoods, dampers, baffles, electrical conduiit, and for arc barriers where high dielectric strength is not required.

Additions to listings:

U-V

UNYTE—Unyte Corp., 521 Fifth Ave., New York. Thermosetting urea-formaldehyde resin. Rapid cure, free flowing. Complete range of light-fast translucent or semi-opaque shades. Nonflammable and good resistance to water and heat.

VIBRACORK — Armstrong Cork Products Co., Lancaster, Pa. Resilient board of granules of cork compresed and baked under pressure; made in four densities to accommodate vibration isolation problems; supplied in boards 12 by 36 inches, in thickness from 1 to 6 inches; other dimensions to order.

VIBRO-PLATE — Korfund Co., 48-15 Thirty-second Place, Long Island City, N. Y. Has a permanently elastic core consisting of a combination of several extremely resilient materials. Pads are applied directly under the legs or base of the machine.

VICTRON—Naugatuck Chemical, Div. of United States Rubber Products Inc., 1790 Broadway, New York. Meta styrene. Can be molded directly from powder. Highly resistant to most chemical re-agents.

VINYLITE—Carbide & Carbon Chemicals Corp., 30 E. Forty-second St., New York. A variety of resins which are odorless, tasteless, chemically inert and nonflammable. Produced as granular powders either white and opaque or transparent and colorless. They may be compounded readily with organic or inorganic fillers and with dyes or pigments to make molding compounds of practically any color or shade. Immune to water, acids and alkalies. Machine cabinets, electrical fixtures, etc., are included in its applications. Rods, sheets and tubes of these resins are available for a wide variety of uses.

VITREOSIL—Thermal Syndicate Ltd., 58 Schenectady Ave., Brooklyn, N. Y. Pure fused silica or quartz in rod, tubing or block forms. High acid, heat and electrical resistance. Low expansion coefficient to 1000 degrees Cent.

VULCABESTON — Colt's Patent Fire Arms Mfg. Co., Plastics Div., Hartford, Conn. Manufacture of this material involves bonding under heat and pressure of a mixture of refined asbestos with a scientific composition which thoroughly impregnates the fibers and forms a sheet that will withstand extreme conditions of service. Furnished as compressed asbestos sheet packing, as ring gaskets cut from the sheets, full face and other types of gaskets, pump valves, etc. Used for water at any temperature; also for use in hot and cold oils, alkali solutions of all kinds, petroleum, naphtha, acids and other destructive fluids.

VULCO—Vulcanized Rubber Co., 261 Fifth Ave., New York. Hard rubber that resists the corrosive action of chemicals such as acids and alkali solutions and will withstand moisture. Has high insulating values and is suitable for use at both low and high voltages and frequencies. Readily molded and easily machined. Characteristics may be varied to accomplish specific results.

VULCOID — Continental-Diamond Fibre Co., Newark, Del. A laminated fibrous base insulating material, hard, dense, pliable and strong. High electrical insulating properties and great resistance to moisture. Adaptable to practically every insulating requirement. May be easily machined, punched or formed. Not readily flammable.

Additions to listings:

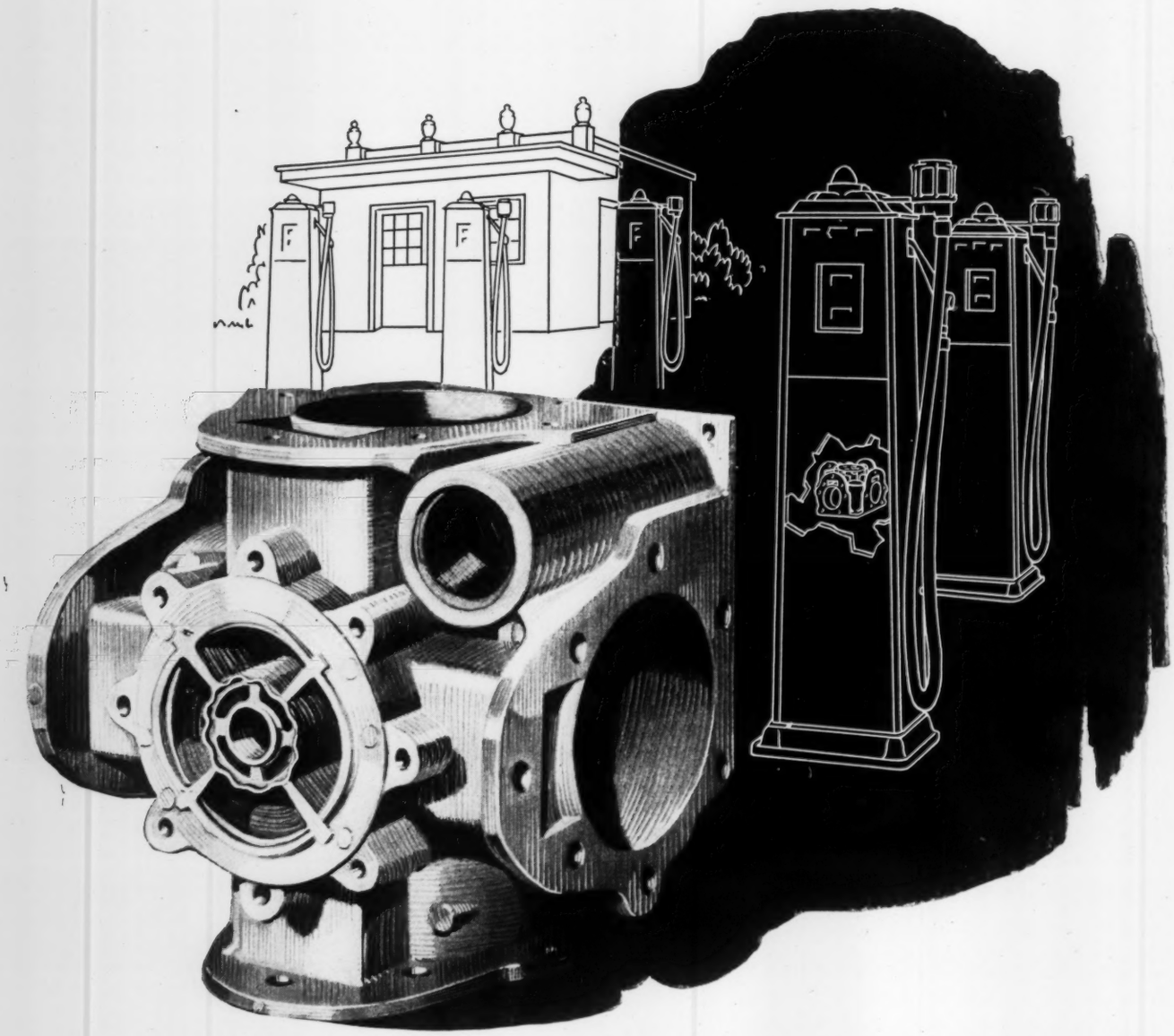
W

WILMINGTON FIBER — Wilmington Fibre Specialty Co., Wilmington, Del. Vulcanized fiber in sheets, rods and tubes. Hard, dense and strong. Can be punched, sawed, turned, drilled, milled and tapped, and by steaming or soaking in hot or cold water, it can be bent and formed.

For further information see ad on page 72-30D.

Additions to listings:

ZINC ALLOY DIE CASTINGS



CAN YOU, TOO, ECONOMIZE ON PRODUCTION?

Irregularly shaped and intricately cored, this meter body for a gasoline pump could only be made so economically . . . so true to its engineering tolerances . . . by Die Casting it of a ZINC Alloy. Other methods of fabrication would have entailed more parts, much milling, boring, grinding and assembling.

The new ZINC Alloys have made Die Castings applicable in so many new fields that *a close survey of product redesign has proved profitable in many cases.* We will gladly furnish you with information on the properties of these new alloys made of Horse Head Special ZINC, and their possibilities.

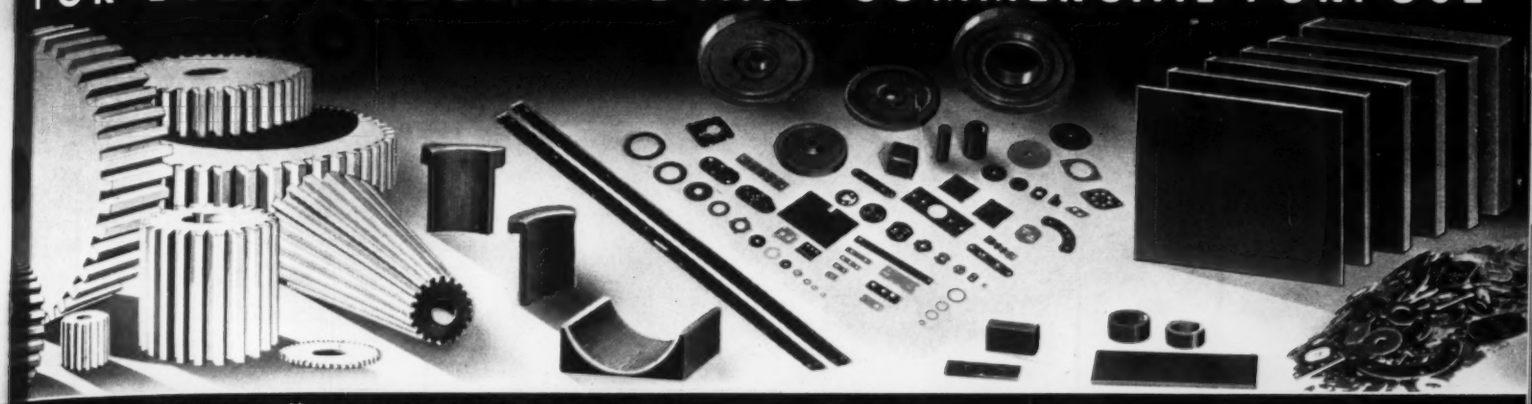
THE NEW JERSEY ZINC COMPANY

160 FRONT STREET NEW YORK CITY

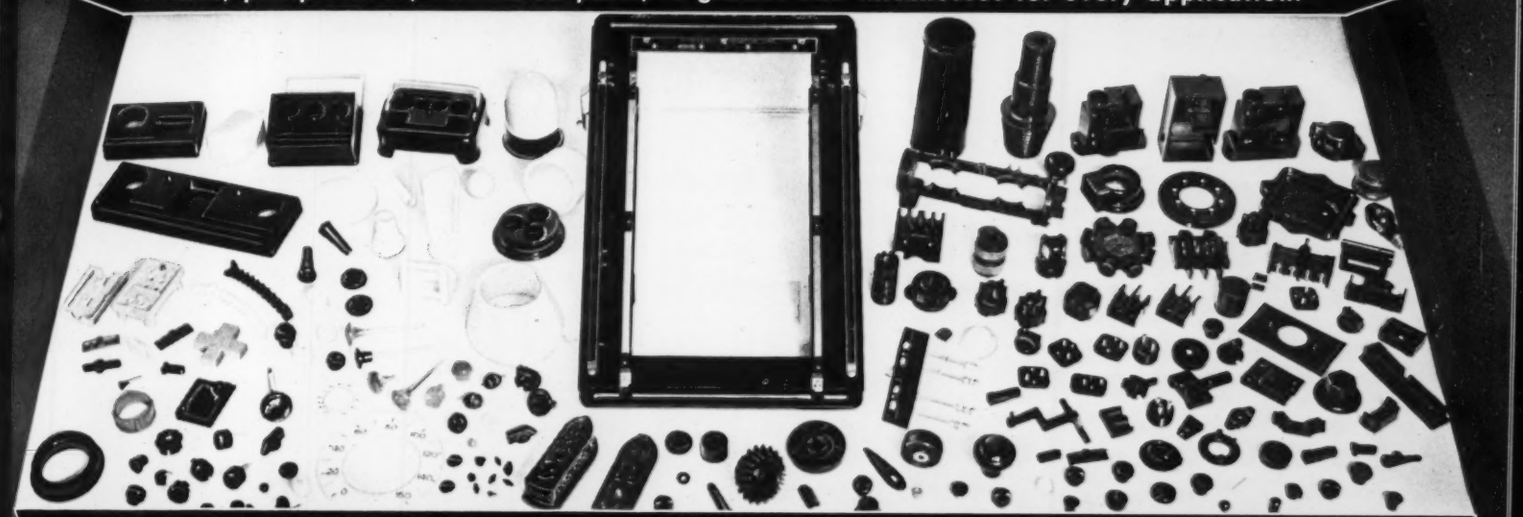
76-34D

Plastics by RICHARDSON

FOR EVERY INDUSTRIAL AND COMMERCIAL PURPOSE



INSUROK "a superior laminated phenolic product," in sheets, rods, tubes, punchings, gear blanks, pump valves, fabricated parts, in grades and thicknesses for every application.



INSUROK molded parts are supplied in every conceivable form, finished to close dimension tolerances, ready for resale or for installation in your equipment.

RUB-TEX hard rubber molded to your specifications for all purposes.

EBROK molded Battery Containers, have proven their superior dependable qualities in over fifty million applications.

Millions of pieces from the tiniest simple designs to the largest intricate precise shapes, some weighing more than a hundred pounds, are molded or laminated every month in the plants of the Richardson organization, the largest in the United States devoted exclusively to the plastic arts.

Richardson can supply your every requirement and you may be assured that you will receive the type and quality of plastic parts especially suited for your requirements.

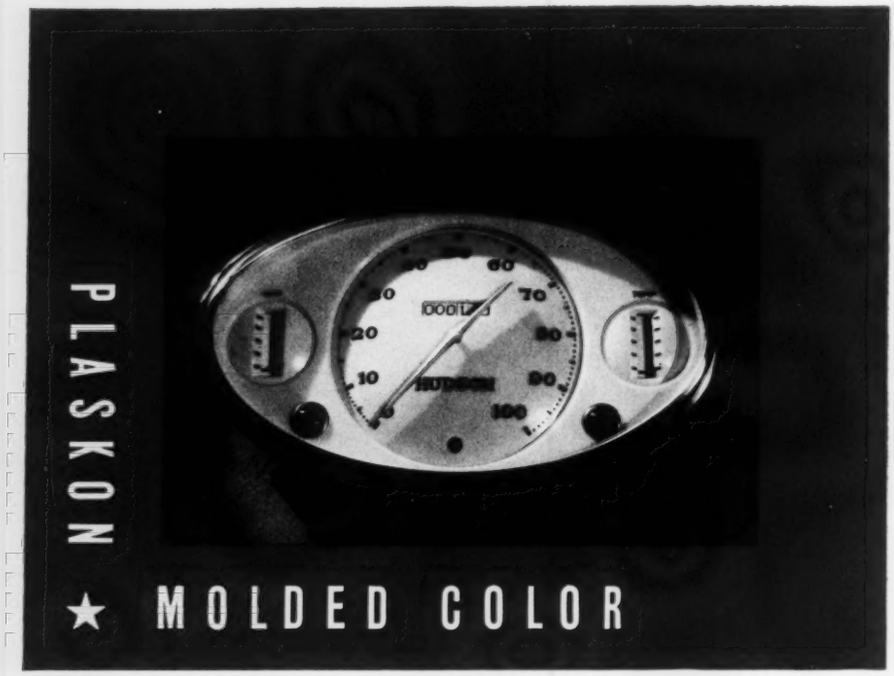
As custom molders of Plaskon, Beetle, Durez, Bakelite, Resinox, Indur, Tenite, and all forms of Synthetic Resin Plastics, the resources of our Research Laboratories, Design and Engineering Departments are at your command.

The RICHARDSON COMPANY

Founded 1858

Melrose Park, Illinois — New Brunswick, N. J.

Detroit Office: 4-252 G. M. Bldg., Phone Madison 9386



MILES AHEAD

Molded Color has long since established itself in the automotive world. Plaskon is now "standard" for the domelights, dials, dashboard knobs, window regulators and the like of many makes. The reasons are simple: Plaskon can match any upholstery; it will not chip, check or become discolored.

Hudson's new speedometer dial is made of Plaskon mainly because of its translucence. The new ivory dial is illuminated by a concealed light. The soft light doesn't disturb the driver yet he can see his miles-per-hour and gauge readings easily. The black-on-ivory figures and lettering offer a high degree of contrast. Chicago Molded Products is the molder of this piece (for Stewart Warner) which is used with variations on many other cars.

In manufacturing lines where products must sell themselves, Plaskon's advantages are even more apparent. Plaskon in its natural color is snowy white, so colors of every tint in the rainbow may be added to produce a finished product in dainty pastel tints or bold solid colors—7,000 of them.

Incidentally, we keep our friends informed of what's new in Molded Color by sending them Plaskon Parade. If you're not getting it, just send us your name and address. We will mail it to you regularly.

MOLDED COLOR

PLASKON COMPANY, INC. · TOLEDO, OHIO

CANADIAN AGENTS: CANADIAN INDUSTRIES LIMITED, MONTREAL, P. Q.

78-36D

Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Metals Do Not Crystallize

To the Editor:

I WOULD like to protest against the careless writing of Willis G. Meyers, who, I am sure, knows better. In his article on "Stress Concentration" in the January issue he says:

"The obvious explanation of this phenomenon was the fact that under repeated loading the metal underwent some change of structure. The surface at the fracture appeared rough and jagged, suggesting a crystalline structure. Therefore, the metal was said to have become 'crystallized' and the term 'crystallization' came to be applied to the sudden failure of metals under repeated stresses."

The only reasonable interpretation of this paragraph is that it is an explanation of fatigue failure, whereas any engineer who pretends to any metallurgical knowledge knows that metal under repeated loading does *not* crystallize. Being a metal it is crystalline before loading. I see red every time an engineer uses the term to explain this type of failure and protest vigorously because of the false impression that some readers of your magazine might receive.

—PROF. E. S. AULT,
Case School of Applied Science.

To the Editor:

WHILE I sincerely appreciate Professor Ault's criticism of my article, I believe he has misconstrued the meaning of the paragraph on which he comments. There was no intention of advocating the use of the term "crystallization," but merely to relate how it first came to be used. The paragraph preceding quite obviously discusses the matter from a historical viewpoint, and this angle is carried into the paragraph under criticism. This expression was, as Professor Ault knows, in very widespread use until recently.

—WILLIS G. MEYERS,
Detroit.

Designing Plain Bearings

To the Editor:

IN REGARD to the chart on designing plain bearings presented in the January issue of MACHINE DESIGN, it seems to me that this chart is not based on actual experience but on several arbitrary formulas. The example cited, showing a pressure of 560 pounds per square inch, is very interesting. Did Mr. Schubert actually build or recommend such a bearing with 560 pounds per square inch pressure? If so, I would like to see the design. He must have had a perfectly lapped-in journal and very carefully run-in bearing, and his temperature was much higher than 160 degrees Fahr. I am afraid that the chart would cause trouble if anybody would take it at face value. The oil film is thinner in the sample bearing than the films used in automobile bearings, and the coefficient of friction would be closer to 0.01 than to 0.002 assumed. Of course, I may be mistaken, and would like to learn the facts if this is so.

—G. B. KARELITZ,
Columbia University.

To the Editor:

REGARDING the comments of Mr. Karelitz relative to the figures in my bearing chart, I would like to note the sources of information used in compiling the chart. After making a study of handbook data on the subject, I concluded that a formula given in *Machinery's Handbook* was most representative and checked closely with other empirical expressions. This is the well-known formula $PV=R/u$ and is based on experiments by Lasche, and is the basis on which the chart presented in the January issue of MACHINE DESIGN was made.

As for the assumption of a coefficient of friction of 0.002, it can be noted from the chart that this figure falls between the pressure lubrication and the ring-oiled lubrication areas and therefore does show a low figure for ring-oiled bearings. However, as pointed out in the descriptive text, the selection of the various figures is left to the judgment of the engineer, the sample bearing illustrated not being intended to represent a recommended set of figures, but rather to show the carrying capacity of the bearing if a coefficient of friction of 0.002 could be anticipated.

According to the German National Bureau of Tests and again by the tests of Stribeck, the coefficient was found to be 0.004 for a ring-oiled bearing under similar conditions of pressure and velocity, the temperature of the oil, however, being kept at less than 160 degrees. If the temperature were allowed to increase, I presume that the coefficient of friction would have dropped accordingly to a lower value.

Of course, I do not wish to appear as well

(*Continued on Page* 96)

MEN of MACHINES

ROBERT E. KINKEAD

WELDING couldn't do without Bob Kinkead. He's as much a part of it as it is of him. A happy mixture of technical knowledge, philosophy and humor makes him one of the outstanding personalities in engineering today.

Robert E. Kinkead was born in Ohio, educated at Ohio State university, was graduated in 1913 as a mechanical engineer. He has devoted his entire career to welding, and because of his thorough understanding of its many phases Carnegie-Illinois Steel Corp. has retained him to make a complete survey of its welding operations.

Since 1927 Mr. Kinkead has done consulting work. Besides holding several patents, he has contributed important developments in rolling mill and other equipment.

• • •

MUIR L. FREY

EVERY metallurgist either directly or indirectly influences design of machinery. This is particularly true of engineers such as Muir L. Frey who was chief metallurgist with John Deere Tractor Co. for ten years. Recently he joined the metallurgical staff of Republic Steel Corp., with headquarters at the Buffalo plant. At John Deere he was active in the improvement of metallurgical and and mechanical technique in the manufacture of tractor transmission gears.

Mr. Frey, born in 1900 at Bunker Hill, Ill., was graduated from University of Missouri School of Mines and Metallurgy in 1923. Early experience was gained with the bureau of mines and at Caterpillar Tractor Co. He also was associated with Gerlinger Electric Steel Casting Co. before joining John Deere Tractor Co.

• • •

STANLEY J. MIKINA

RESPONSIBILITY for the future rests on the young engineer. That's why the American Society of Mechanical Engineers annually makes a junior award which this year went to Stanley J. Mikina. He was honored for a paper on magnetic noise in electrical machinery.

Graduating in 1930 from University of Michigan, he entered the student course at Westinghouse. Later he became a member of the company's research staff. Among the more important projects with which he has been connected are those directly related to the design of machinery. For example, he has done considerable work in the elimination of noise and vibration from submarine drive motors, power transformers and gear drives. In addition Mr. Mikina has conducted studies in the dynamics of

M-R-C incorporates all the design refinements of thirty-eight years of engineering experience in each of its twenty-three bearing types. Add to this, manufacturing control that assures uniform production of all dimensions . . . and you have the reason for the high operating efficiency of M-R-C Ball Bearings . . . Gurney - SRB - Strom.

●

MARLIN-ROCKWELL CORPORATION
JAMESTOWN, N. Y.
Factories at **JAMESTOWN • PLAINVILLE, CONN. • CHICAGO**

M-R-C
Ball Bearings
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PRECISION

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in 108 distinct series

To the machinery world, NORMA-HOFFMANN offers the most comprehensive line of anti-friction bearings in America—108 distinct series—ball, roller, needle and thrust types—1/8" to 21" bore, metric and inch sizes.

Many of these types have been pioneered by NORMA-HOFFMANN engineers to meet specific requirements growing out of advancing methods in machine design, manufacture and operation.

Today, with this wide choice of PRECISION BEARINGS available, engineers are no longer compelled to adapt their designs to the comparatively few standard bearing types of past years. There's a PRECISION BEARING for every load, speed and duty.

Write for the Catalog. Let our engineers work with you.

NORMA-HOFFMANN BEARINGS CORP'N.

STAMFORD, CONN., U. S. A.

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST

gyroscopic action, with applications to the design of high speed overhung machinery such as rayon bucket spinners and centrifuges. Development of vibration instruments and appliances also has been included in his activities as a research mechanical engineer.

♦ ♦ ♦

JOHN BRUNNER, Chicago district, Carnegie-Illinois Steel Corp., was recently awarded the John Ericsson gold medal by the American Society of Swedish Engineers at its annual meeting in New York. The award was made in recognition of his research in connection with steel normalizing processes.

♦ ♦ ♦

C. E. STRYKER has resigned as vice president and chief engineer of Fansteel Products Co., North Chicago, Ill., to become associated with McKinsey-Wellington & Co., Chicago, management engineers.

♦ ♦ ♦

C. C. HENNING, assistant general metallurgist of Jones & Laughlin Steel Co., Pittsburgh, was awarded the Robert W. Hunt prize by the American Institute of Mining and Metallurgical Engineers for a paper on "Manufacture and Properties of Bessemer Steel," read before the institute a year ago.

♦ ♦ ♦

DR. NORMAN A. SHEPARD, since 1919 director of the research laboratories of Firestone Tire & Rubber Co., has been appointed director of technical service for American Cyanamid Co., New York.

♦ ♦ ♦

R. E. W HARRISON, who has contributed a number of articles to MACHINE DESIGN, is one of the partners in a new company, Clarke-Harrison Inc., Packard Bldg., Philadelphia. The firm will act as consultants in management and engineering.

♦ ♦ ♦

ROY COLE recently was appointed chief engineer in charge of all engineering of the Studebaker Corp. He has been connected with various engineering activities of the industry for many years and until recently was chief engineer of Dodge.

♦ ♦ ♦

S. C. PARTRIDGE recently was appointed assistant general manager of the industrial division of Timken Roller Bearing Co., Canton, O. Joining the organization in 1925, he worked first in the shop and then in the engineering department.

♦ ♦ ♦

LOUIS C. EDGAR, recently appointed chief engineer in the Pittsburgh district for Carnegie-Illinois Steel Corp., formerly was chief engineer of the Edgar Thomson works of the company at Braddock, Pa.

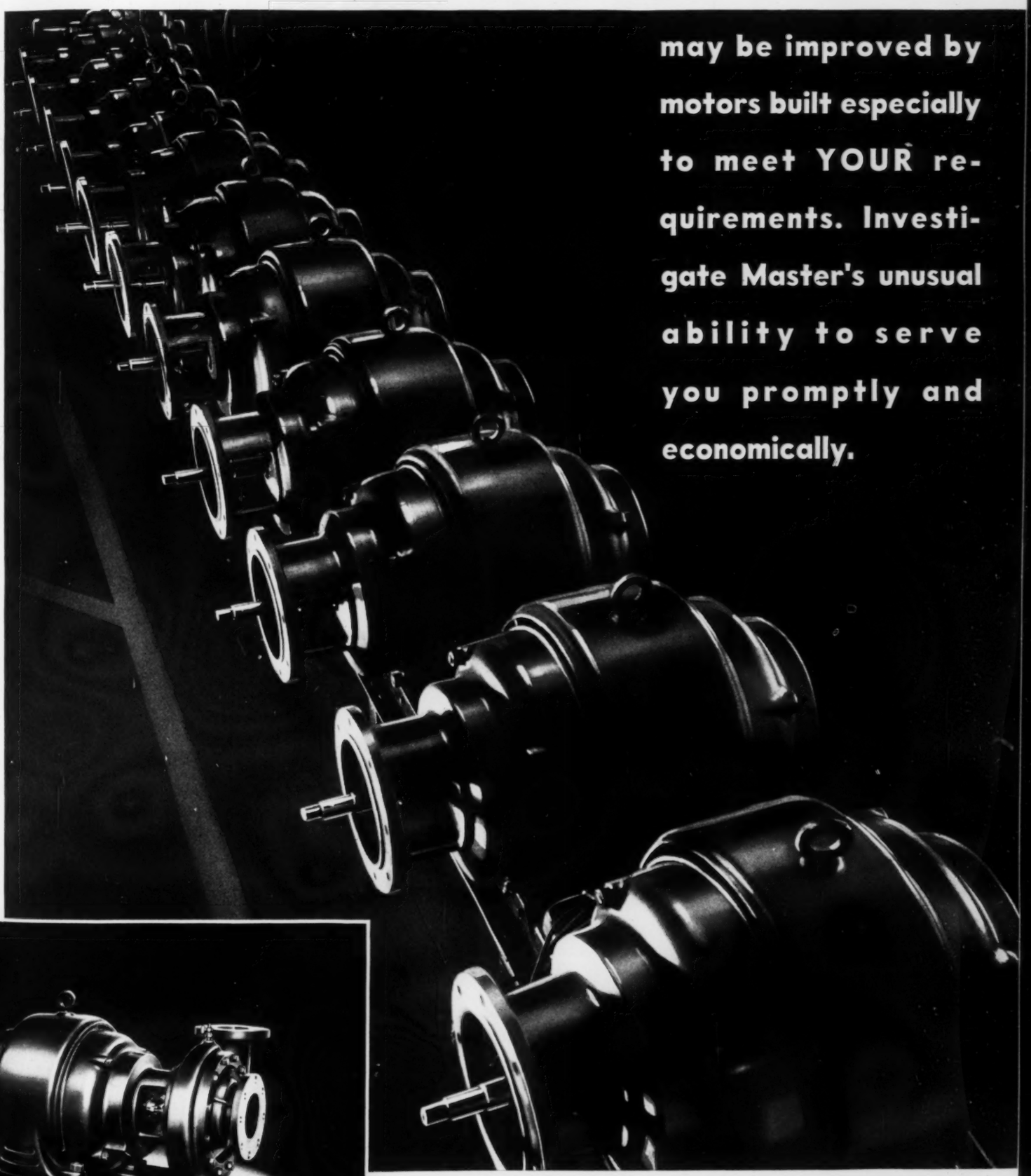
♦ ♦ ♦

F. H. CROCKARD, metallurgist of Republic Steel Corp., at Thomas, Ala., recently received the J. E. Johnson Jr. award of the American Institute of Mining and Metallurgical Engineers.

♦ ♦ ♦

DR. ARTHUR CUTTS WILLARD, president of the University of Illinois, recently received the F. Paul Anderson gold medal awarded by the American Society of Heating and Ventilating

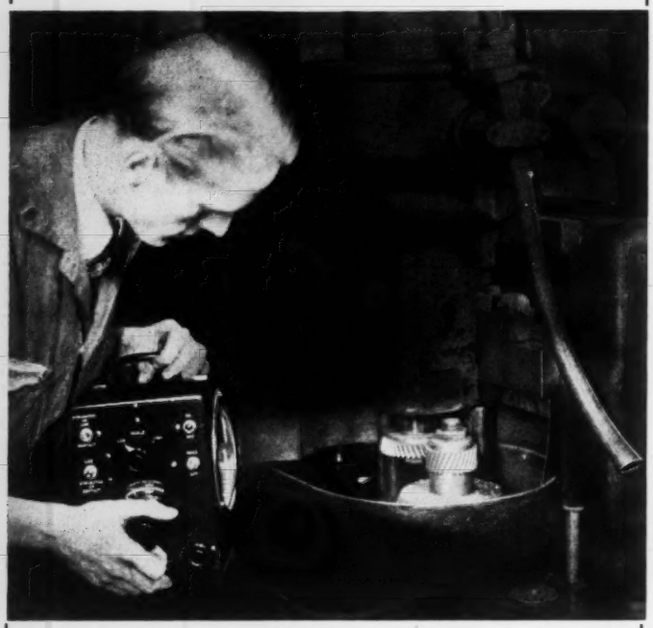
YOUR PRODUCT



may be improved by motors built especially to meet YOUR requirements. Investigate Master's unusual ability to serve you promptly and economically.

THE MASTER ELECTRIC COMPANY

Insuring Correct Operation



not only of this high speed automatic gear shaper but of any machine is simple with the STROBOTAC.

Study slow-speed motion of high speed machinery. Stop motion in gears, cams, tapping machines, springs, bearings, grinders, motors . . . in any machine to see exactly how it performs.

The STROBOTAC throws a beam of light, the flashing rate of which can be synchronized with any periodic rotating or reciprocating machine or part to 'stop' its motion. When adjusted slightly out of step with the motion of the machine, slow-speed observation (as low as a fraction of an rpm) of high speed machinery is possible.

The Type 631-A STROBOTAC has a speed range of 600 to 14,400 rpm, directly read to 2% on a dial. It is portable, weighing only 12 pounds, and it is complete and ready to operate from any 110 volt 60 cycle a-c line. Its price is $95.00.

Write for Bulletin DA for Complete Details

GENERAL RADIO CO.

30 State Street Cambridge, Massachusetts

Engineers for distinguished scientific achievements in the field of heating, ventilating and air conditioning. May, 1934, issue of MACHINE DESIGN contains a picture and biographical sketch of Dr. Willard.

♦ ♦ ♦

R. A. DONALDSON, newly appointed metallurgist of Woodward Iron Co., Birmingham, Ala., has been engaged in metallurgical and research work for the past fifteen years.

♦ ♦ ♦

I. LAMONT HUGHES, executive vice president of Carnegie-Illinois Steel Corp., Pittsburgh, is the new president of the Engineers' Society of Western Pennsylvania.

♦ ♦ ♦

LEWIS B. STILLWELL recently was awarded the 1935 Edison medal by the American Institute of Electrical Engineers for distinguished engineering achievements and pioneer work in the generation, distribution and utilization of electrical energy. He is a consulting engineer in Princeton, N. J.

♦ ♦ ♦

DR. VANNEAR BUSH, vice president of Massachusetts Institute of Technology, has been awarded the 1935 Lamme metal for his development of methods and devices for application of mathematical analysis to problems of electrical engineering.

♦ ♦ ♦

CLYDE E. WILLIAMS, new chairman of the iron and steel division of the American Institute of Mining and Metallurgical Engineers, is director of Battelle Memorial Institute, Columbus, O. In addition to his administrative duties at Battelle he has been since 1929 in direct charge of technical work connected with the iron and steel industry.

♦ ♦ ♦

LOUIS JORDAN, who has had a long experience as chief of section on thermal metallurgy and assistant chief of the division of metallurgy, National Bureau of Standards, Washington, has been appointed secretary of the Institute of Metals Division and secretary of the Iron and Steel Division of the American Institute of Mining and Metallurgical Engineers.

Obituaries

FRED R. LOW, editor emeritus of *Power*, died recently. He was a past president of the American Society of Mechanical Engineers.

♦ ♦ ♦

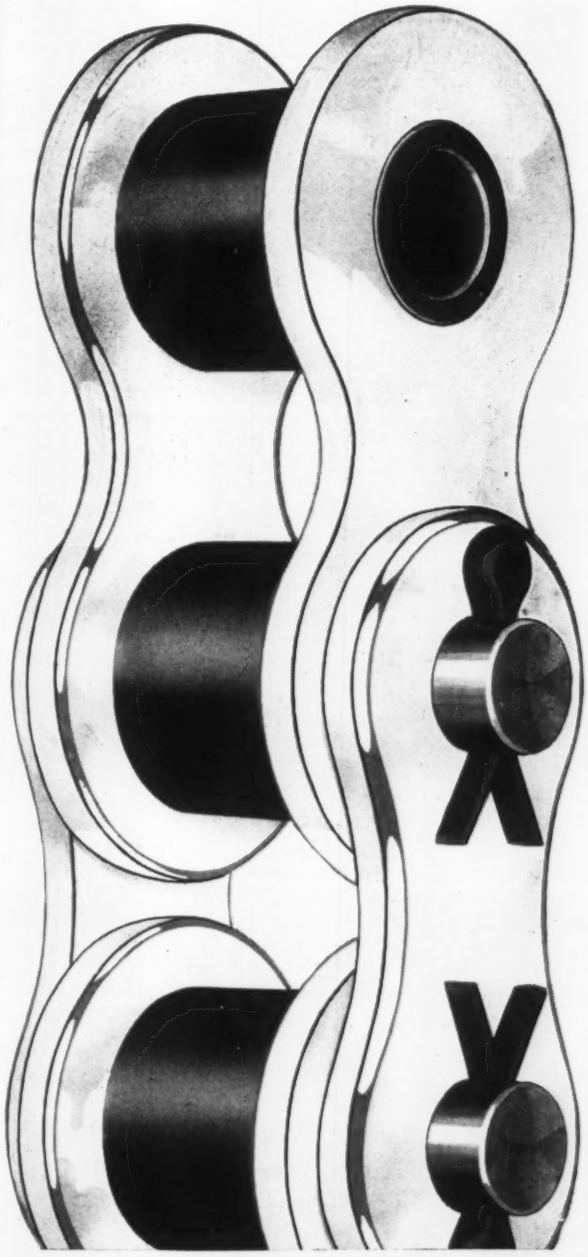
HARRY A. MCELDOWNEY, chief engineer of National Steam Pump Co., Upper Sandusky, O., died recently. He became connected with the organization thirty-three years ago as a draftsman.

♦ ♦ ♦

ROBERT MITCHELL, for many years chief designer for the Steel Co. of Canada, and a veteran employe of its Hamilton, Ont., works, died recently.

♦ ♦ ♦

WILLIAM R. JEAVONS, inventor of the wickless oil burner and holder of several oil stove patents, died recently in Cleveland. He was head of the experimental department of Perfection Stove Co. when he retired in 1912.



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Silverlink

ROLLER CHAIN

for Drives and Conveyors

● For accurate pitch, smooth operation, long life and dependability, specify Link-Belt Silverlink roller chain. It is the result of unending research work and of the long experience of the leader in the art of chain manufacture.

Silverlink is made in ⅜" to 2½" pitch, in single and multiple strand types, with a complete range of sprocket wheels and attachments. Complete drives—chains and sprocket wheels—from ¼ to 225 H. P., in speed ratios of 1 to 1, up to 8 to 1, are stocked by distributors, nationally.

LINK-BELT COMPANY 5564A

The Leading Manufacturer of Positive Power Transmitting Equipment

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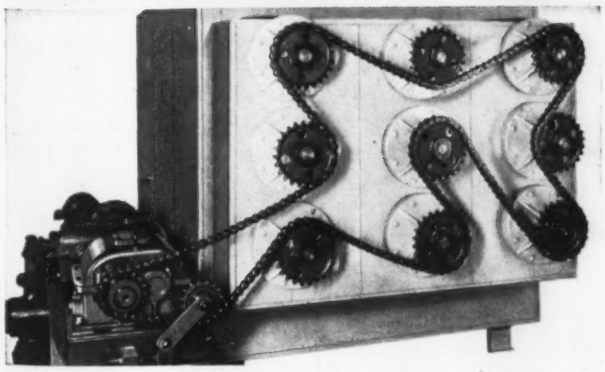

LINK-BELT *positive* DRIVES INCLUDE

SILENT CHAIN DRIVE

ROLLER CHAIN DRIVE

HERRINGBONE GEAR REDUCER

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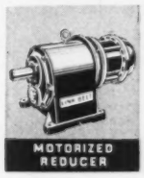


MOTORIZED REDUCER

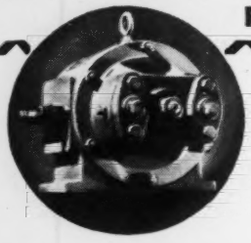
P.I.V. GEAR SPEED VARIATOR

V.R.D. VARIABLE ROLLER DRIVE

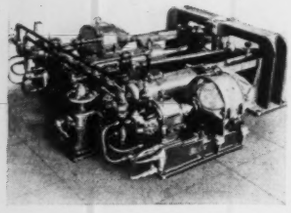
HELE-SHAW *Fluid* POWER

A NEW CONCEPTION OF FLEXIBILITY IN MACHINE DRIVES

NEWS FLASHES



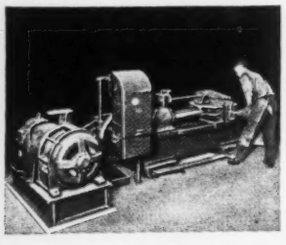
FLUID POWER ABSORBS SHOCKS



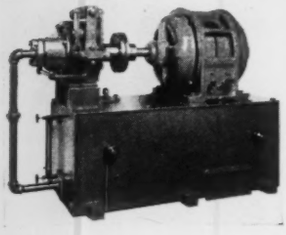
Approximately 150 American vessels—tugs, tankers, seatrains, passenger carriers, destroyers, cruisers, coast guard cutters and pleasure craft—are steered by A-E-CO steerers powered by Hele-Shaw hydraulic pumps. The ability of the oil fluid medium to cushion rudder shock is equally important in extending the life of machines and machine tools.

HIGH PRESSURES EASILY CONTROLLED

One of the outstanding advantages of Fluid Power is the ease with which high hydraulic pressures are controlled. On this bulldozer, for example, the Hele-Shaw pump may be sensitively adjusted for a wide variation in strokes per minute. Variations can be effected through the use of manual, semi or fully automatic Hele-Shaw Regulators.



COMPLETE PUMPING UNITS



It is usually desirable and often possible to mount a Hele-Shaw pump or transmission on an oil reservoir base. Complete, compact Hele-Shaw Pumping Units—including the reservoir, regulator, flexible coupling and prime mover—are available in a range of reservoir designs and capacities.

WHAT IS YOUR PROBLEM?

Possibly you don't build or operate steering gears or bulldozers but if your problem involves the use of variable or reversible *linear* or *rotary* motion, perhaps we can help you. Hele-Shaw Fluid Power pumps, motors and transmissions have been successfully applied to over 200 types of machines.

Send for Catalog F

AMERICAN ENGINEERING

AMERICAN ENGINEERING COMPANY

2502 Aramingo Avenue, Philadelphia

BEFORE YOU DESIGN, BUILD OR BUY MACHINERY, GET THE FACTS ABOUT HELE-SHAW *Fluid* POWER

Topics . . .

ENGINEERING materials are making history, if not changing the course of civilization. Witness the influence of the development of plastics on design in the mechanical field. Innovations are too numerous to name here, but many are discussed in an article in this issue.

♦ ♦ ♦

Metallurgical and chemical achievements that once had only laboratory signficance now absorb the interest of the public which is becoming more and more materials conscious. Within the past two weeks the news that aluminum had been adopted for the wheels, side plates and cutter bars of a lawnmower was prominently played up in the public press. The interest in the feature, however, goes deeper in this case than mere curiosity in what materials are employed—the average man anticipates a lighter machine that will require less brawn to operate!

♦ ♦ ♦

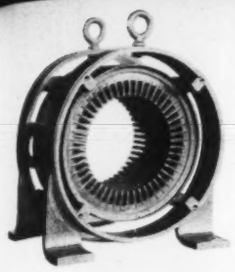
Just as the aluminum lawnmower is indicative of the search for new markets, so also is a new glass air filter for internal combustion engines, air compressors and ventilating units. It consists of a series of bonded mats of flexible glass fibers. The subject of air filters brings to mind the airconditioning field that holds promise for steel consumption of consequence in the future.

♦ ♦ ♦

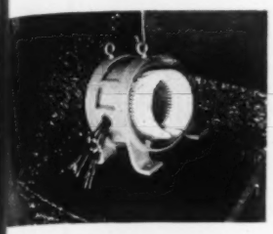
The growing popularity of alloy steels is perhaps best illustrated by a statement of W. F. Detwiler, executive vice president, Allegheny Steel Co., to the effect that his company had an increase of 16 per cent in volume and 18 per cent in value of alloy steel sales during the first 10 months of 1935 compared with the corresponding period of 1934. These gains represent not only improved business conditions but the increasing use of alloys by an ever widening group of consumers as well.

♦ ♦ ♦

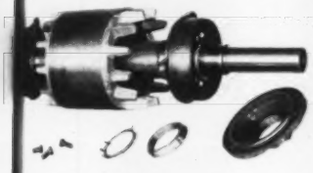
Quoting our contemporary, *Daily Metal Trade,*



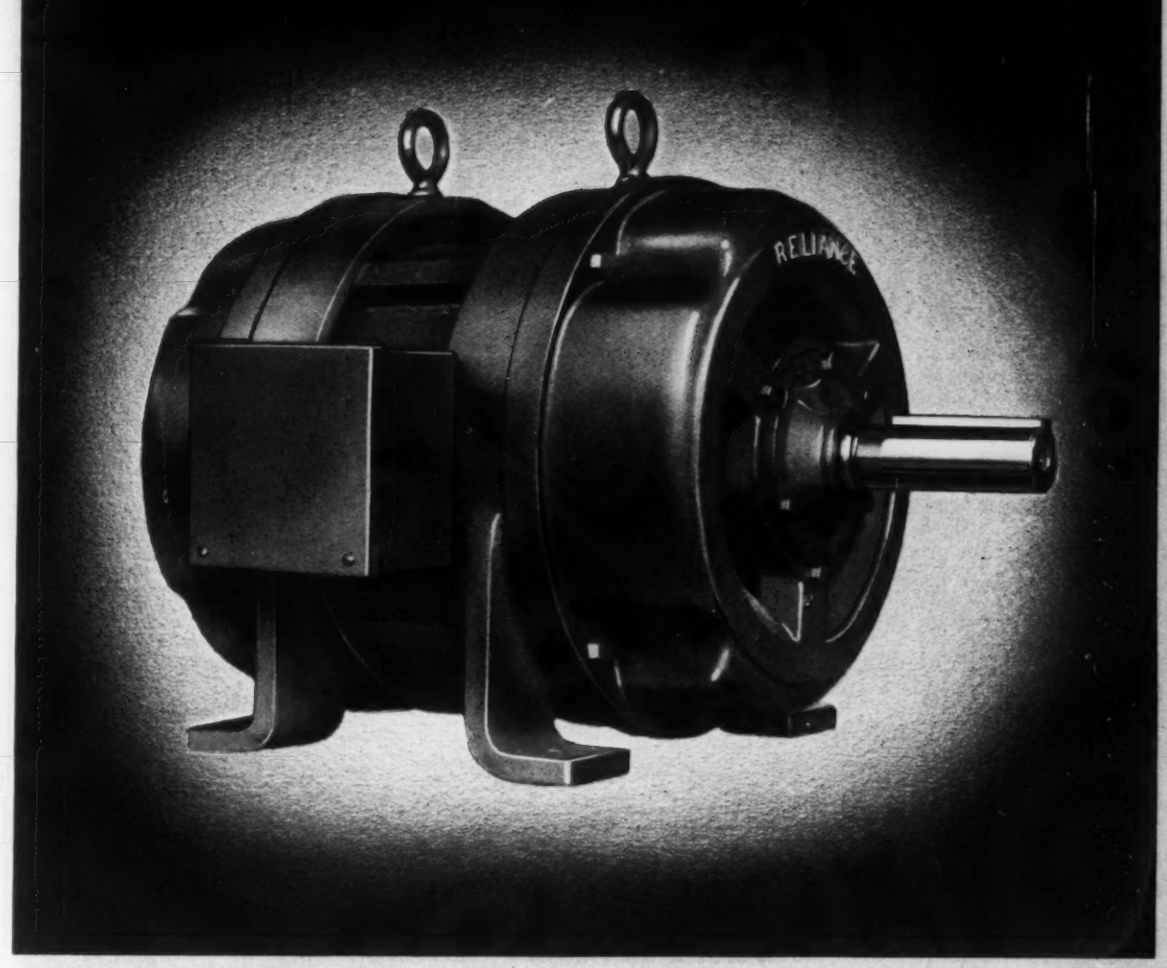
Rugged all-steel frames are used for all sizes. They insure permanent alignment of the stator core within a rigid housing. Air gaps stay uniform.



Three varnish treatments, three overnight bakings, and a coat of protective enamel provide windings of semi-enclosed slot stators with unusual protection against the destructive influence of oil, dust and moisture.



Rotors are trouble-proof. Bars, short-circuiting rings and fans are cast under high pressure as an integral section of aluminum. Dust-tight cartridges protect the ball bearings from dirt.



Type AA Squirrel-cage Induction Motor with Ball Bearings
(Frames 202-405)

Reliance Design PROMOTES STEADY, LONGER RUNNING

Thoroughness—a good old Anglo-Saxon word. Applied to Reliance Type "AA" design, workmanship and inspection, it points to dependability and long life. Thorough-going strength in every part, suggested instantly by the rugged all-steel frame used in all sizes. Stators built and wound with extreme care . . . the windings insulated against dust, moisture and fumes by the Duraseal process, which includes three coats of varnish and one of enamel, with over-night bakings in between. Cast-type rotors with sturdy ball bearings, bearings thoroughly safeguarded from dirt by dust-tight cartridges. These and other features make for long, steady running on the tougher jobs. For details see our *new* Bulletins 118 and 119.

This checking plate is used to verify the accuracy of important dimensions such as shaft height and the spacing of holes for holding down bolts.

Mechanical parts for Reliance Type "AA" Motors are inspected at each operation. A final examination is given each part before it goes into stock.

RELIANCE ELECTRIC & ENGINEERING COMPANY
1050 Ivanhoe Road — Cleveland, Ohio

Branches: Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, New York, Philadelphia, Pittsburgh
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RELIANCE A-C D-C MOTORS

Perhaps **"GRIZZLIES"** *are out of your line . . .*

—but the delivery of a reliable flow of power is uniformly important, *whatever* equipment you may be planning or redesigning.

Knowing the excellence of Cleveland Worm Gear Drives by reputation—and, we hope, by your own favorable experience—you can specify them with real confidence. First, that "Cleveland" *knows how:* 24 years' experience building quality worms and gears has taught a lot, and "Cleveland" *still* is building worms and gears exclusively.

Second, that "Cleveland" is constantly painstaking in all important respects: engineering and design; materials-selecting and testing; precision shop practices; exactness in adapting each Drive to its lifetime job.

Why not talk to "Cleveland" about that new job of yours? A competent Engineer, located near you, will gladly call. The Cleveland Worm & Gear Company, 3275 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland. Manufacturers of Centralized Systems of Lubrication.

CLEVELAND *Worm Gear Drives*

the price spread between ordinary steels and alloy steels is so wide, alloys commanding from 20 cents to $2 per pound as against approximately 2½ cents a pound for ordinary steels, that the increased use of alloys must be significant of something fundamental in character taking place in industry. Their applicaton on an ever broadening scale unquestionably testifies to their importance in the solution of many design and production problems.

♦ ♦ ♦

Consumption of materials such as rubber also is showing a distinct rise. Crude rubber, for example, used in the United States in 1935 was the highest on record. Amount consumed was approximately 497,150 long tons, which compares with 453,223 tons during 1934 and 401,000 tons in 1933. Previous record established was in 1929 when 467,400 tons were consumed.

♦ ♦ ♦

What is believed to be the largest steel casting ever produced west of Pittsburgh was poured recently at Hubbard Steel Foundry division of Continental Roll & Steel Foundry Co., East Chicago, Ind. It was a rolling mill housing weighing 160,000 pounds. At Rockefeller Center, New York, an extensive exhibit of die castings opens on March 16. Twenty-seven commercial die casters are co-operating to make this the most comprehensive showing of zinc, aluminum and brass die castings ever held in this country.

♦ ♦ ♦

Have you heard about Dr. H. K. Ihrig's new process, perfected after five years work, by which ordinary steel may be made resistant to corrosion? He says it is somewhat similar to case-hardening, except that the steel is impregnated with silicon instead of carbon and not reinforced with a surface coating. It is called Ihrigizing.

♦ ♦ ♦

Chrysler is announcing an improved spring leaf design, made possible by a new steel known as Amola. Because the steel has an extremely high elastic limit, spring leaves can be made thinner and the ends tapered in thickness, thus distributing the leaf-to-leaf load over a greater bearing surface to enhance riding qualities of autos.

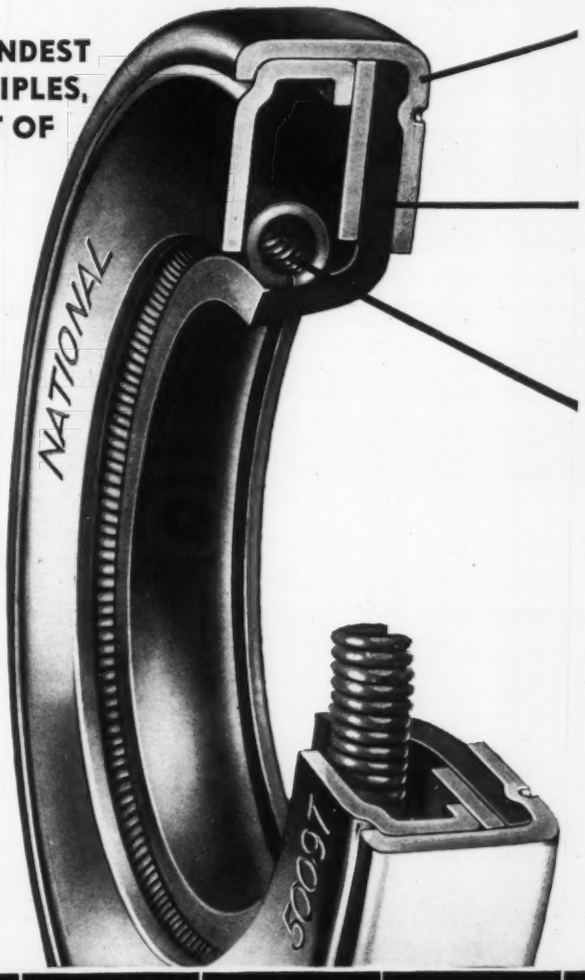
♦ ♦ ♦

Reports come from abroad that Russia has developed collapsible rubber gliders for aircraft, as well as a propeller of rubberized material. Germany claims to have perfected synthetic rubber tires superior to the raw rubber product. And Dr. Alexander Klemin, director of the Guggenheim School of Aeronautics, predicts gigantic aluminum alloy rocket ships flying at a height of 20 miles with speeds in excess of 1000 miles per hour. Who knows?

The original peripheral-tension closure

PRESENTING THE SOUNDEST ENGINEERING PRINCIPLES, FOR THE ATTAINMENT OF AN IMPERVIOUS SEAL

Every designing engineer who has labored with the problem of sealing a rotating shaft will quickly appreciate the simplicity of the National Oil & Fluid Seal. Only a "live" closure that "follows" every move and vibration of the shaft can effectively seal or economically endure. The irreducible compactness of National Seals accomplishes large savings in the machining time of all products on which they are used. Their press-fit accuracy avoids the need of follower-plates; threaded rings or bolted glands. Installation is extremely simple and quick. Every day finds more engineers incorporating National Seals into their designs.



Press-Fit Accuracy

The outer one-piece U-shaped case is made much stronger than necessary. Press-fit distortion is avoided by this extra strength. Outer diameter has .002" plus or minus tolerance.

Resilient Long-Life Sealing Member

Made from leather processed to rigid specifications in our own factory. Standard sizes are regularly furnished with long-life double-tanned SAETAN leather.

Endless Closure Spring

The use of an endless spiral spring is the only sure way of obtaining equalized-peripheral tension. The resultant "live" closure maintains maximum sealing effect with minimum wear and friction.

—FOR EVERY ENGINEERING NEED

National Oil and Fluid Seals are adaptable to every type of machine . It makes no difference if an unbalanced pressure exists—if shafts turn fast or slow—if the liquid or oil is hot or cold. Regardless of the need there is a National Seal for the service.

Representative Machine Applications

Automobiles
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Coal Stokers
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Ice Machinery
Pumps
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Mining Machinery
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Bearing Boxes
and many more

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OIL & FLUID SEALS

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Engineers will find our Industrial Catalog of real value. It shows many actual uses of the various types of National Seals.

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Send a copy of Industrial Catalog and a sample seal, without obligation.

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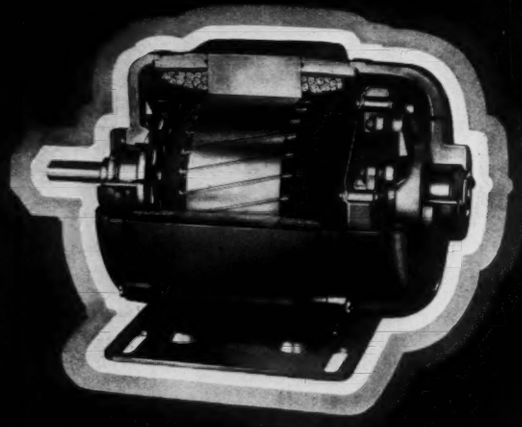
THE MORE YOU KNOW *about* MOTORS...



...the MORE you'll appreciate BALDOR'S advanced designing and precision engineering

A close up of a Baldor Motor reveals such quality features as . . . liberally designed vital working parts . . . a larger proportion of motor weight is ACTIVE MATERIAL . . . oversize bearings and shafts of highest grade material.

Rotors and armatures are dynamically balanced . . . indestructible Polyphase rotors and sine wave Repulsion Induction stator windings are among the many advancements originated and developed by Baldor.

The Baldor guarantee is definite assurance of performance—not a mere promise of free repairs and replacements.

BALDOR ELECTRIC COMPANY
4352 Duncan Ave., St. Louis, Mo.

BALDOR
A BETTER MOTOR

Noteworthy Patents

BIMETAL strip, an engineering material that is becoming increasingly important, makes possible the steam-operated automatic electric plug switch shown in *Fig.* 1. Designed and patented by A. C. Wilcox for Enterprise Aluminum Co., this device is especially adapted for use with electrically operated cooking equipment. Ball cavity *A* engages nose *B* of the steam nozzle connected to the water container of the apparatus to be controlled. As the switch lever is manually actuated, compressing spring *J*, metal contact knob *C* moves into contact with jaws *D* to close the electric circuit. At the same time arm *E* is moved by rotation of switch member *F* until ball lock *G* is received in the hole in the bimetal strip *H*, which flexes upward into place as shown in *Fig.* 1. Thus rotary switch member *F*

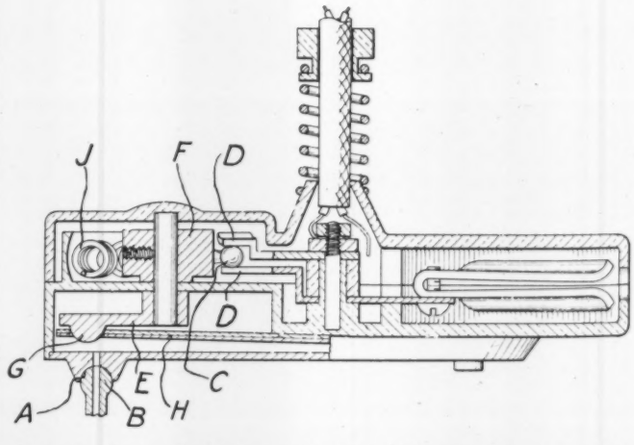
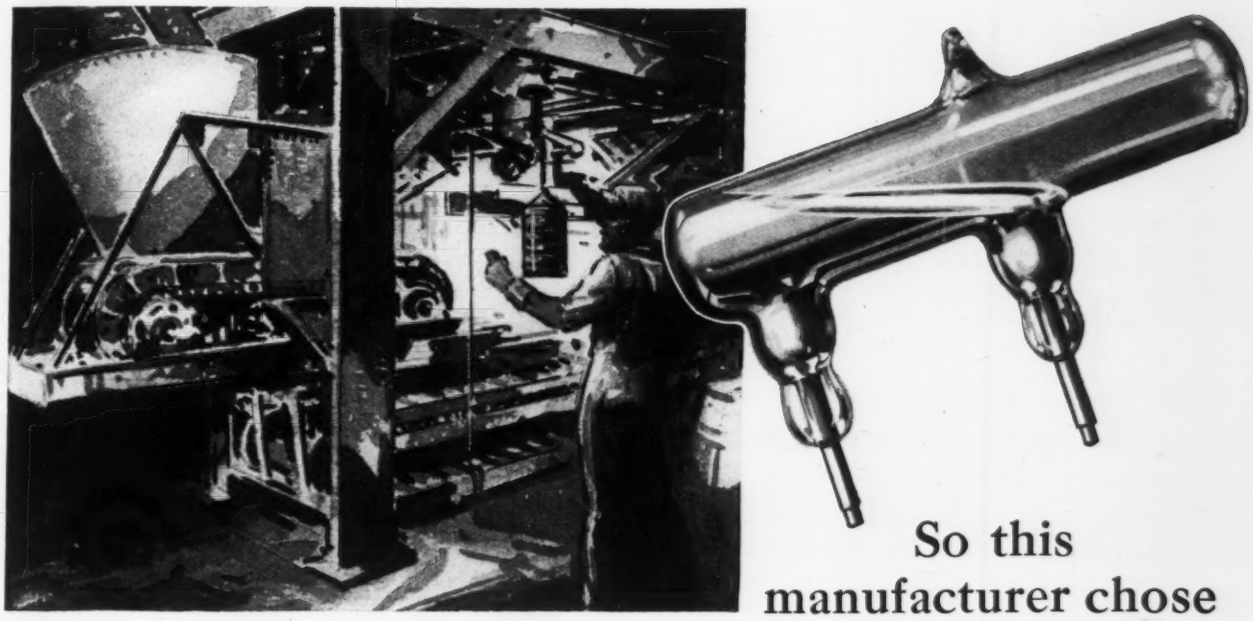


Fig. 1—*Thermostatic properties of a bimetal strip in contact with steam are utilized to control electric current*

It's not easy to service a scale *in Waikiki . . . .*



So this manufacturer chose

KON-NEC-TORS

(Mercury-to-Mercury Switches)

This manufacturer makes special material handling machinery and scales that are shipped to remote lands, where it is practically impossible to get adequate or frequent engineering service. Therefore operation of the electrical control system must be reliable and trouble-free and must continue to function year after year without inspection.

That is why this manufacturer chose KON-NEC-TORS, the mercury-to-mercury switch, for his make and break contacts. KON-NEC-TORS permit this maker to build machines for a much wider field than was possible had mechanical controls alone been used.

With KON-NEC-TORS, *there are no delays due to dust accumulations or corrosion on the switches. Being wholly glass-enclosed,* KON-NEC-TORS *can be used safely in an atmosphere of explosive gases. Their operation is quick and definite, and weighings can be made more quickly with each operation distinct from the one preceding and following it.*

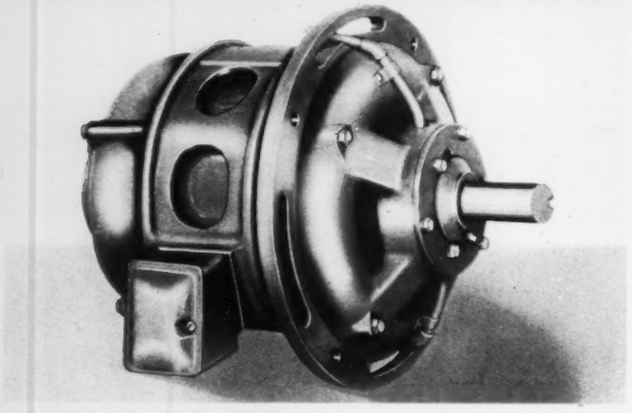
The same points that caused this scale manufacturer to select KON-NEC-TORS make it the ideal switch wherever quick, positive make and break contact is a necessity. Write for complete information. General Electric Vapor Lamp Company, 825 Adams Street, Hoboken, N. J.

GENERAL ELECTRIC VAPOR LAMP COMPANY

678

Your customers know . . .

DIEHL MOTORS



DIEHL produces all motors used by its parent company, The Singer Manufacturing Company, on its famous sewing machines. Many other leading manufacturers of motor-driven machines and devices have standardized on Diehl equipment.

Throughout the world, Diehl products are held in highest regard by satisfied users in every phase of industry, and in the field of transportation by major steamship companies and railroad systems.

Whether your requirements call for standard or special motor equipment, consider Diehl, and be assured of customer-acceptance.

For a quick survey of possibilities write for a copy of the new Diehl Simplified Price List and Catalog of motors and ventilating equipment.

DIEHL MANUFACTURING CO., Elizabethport, N. J.
Electrical Division of THE SINGER MANUFACTURING CO.
ATLANTA BOSTON CHICAGO DALLAS NEW YORK PHILADELPHIA

6933-A

is locked to hold contact knob *C* in closed position between jaws *D*.

As soon as sufficient steam pressure has been created in the cooking equipment, the contact of the steam with the bimetal strip causes it, through its thermostatic properties, to flex away from arm *E* until the ball lock is released. At this juncture spring *J* will expand, instantly throwing the switch elements apart to break the contact between ball *C* and jaws *D* which cuts off the current to the heating element.

Number of this patent is 2,030,083.

THAT metallurgical apparatus is keeping abreast of the trend toward further mechanization is revealed in the design of equipment, *Fig.* 2, for casting and conveying metal billets, bars and slabs. This machine is designed as a

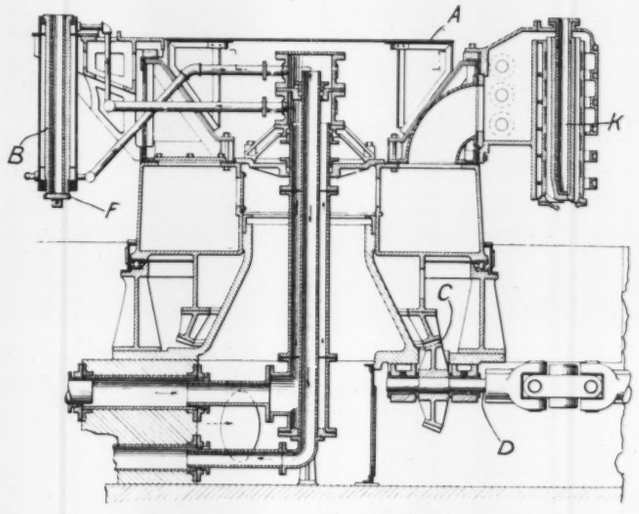
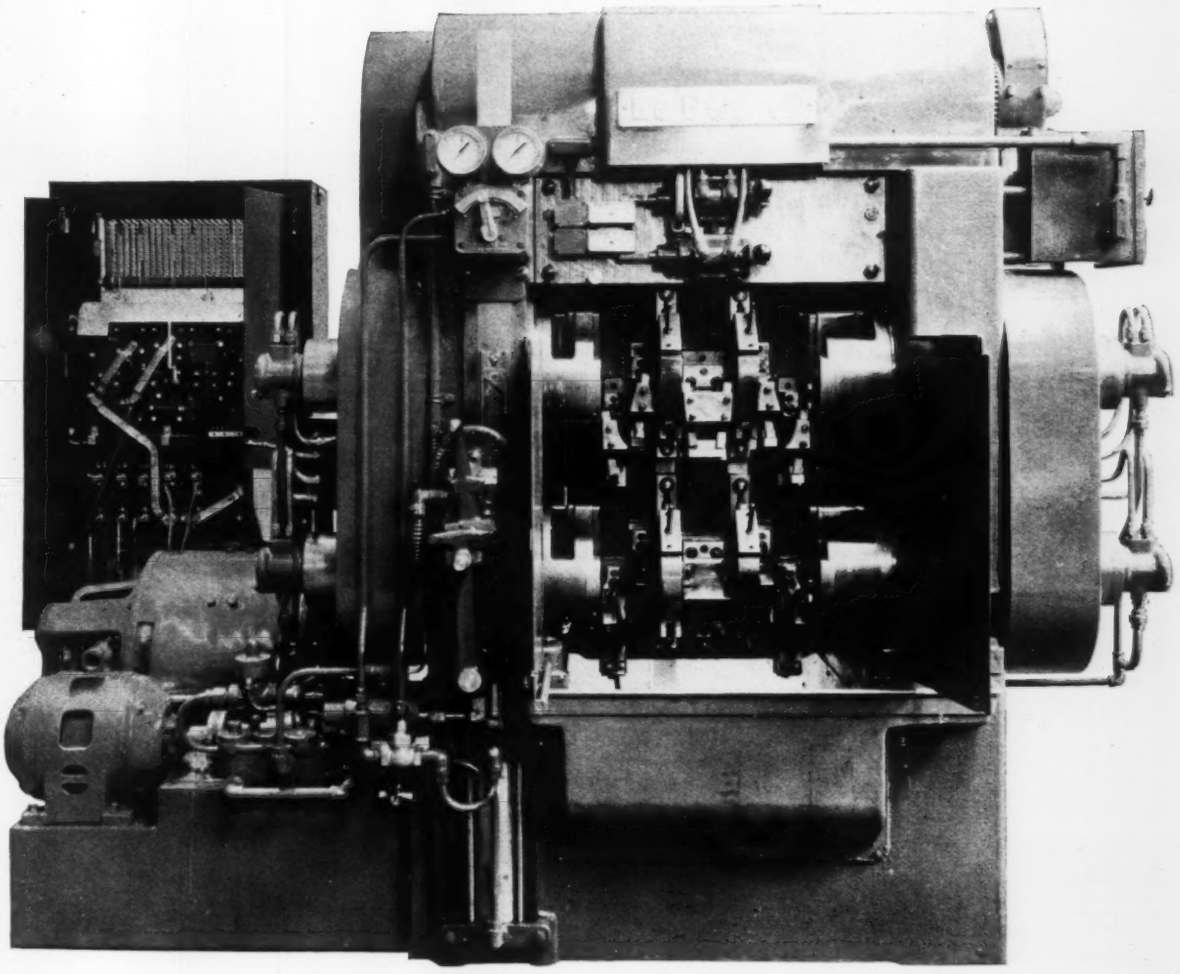


Fig. 2—Full advantage of mechanization has been taken in the design of this metallurgical apparatus

unit of a plant for producing oxygen-free copper. Mold wheel *A* is equipped to supply either water or air for cooling the molds, the aircooled type being shown at *K* and the watercooled at *B*.

Mold wheel *A* is provided with a bevel gear *C*, driven by a pinion fixed on drive shaft *D*. The wheel is turned until a mold *B* comes beneath the opening of a strainer. Hood and strainer assembly is lowered into sealing engagement with the mold. Mold cap *F* hangs slightly open as the mold arrives at the pouring position and when halted the cap is pushed up tightly against the bottom of the mold by an hydraulically-operated ram. The aircooled type of mold however, does not have the hinged type of bottom so the ram is not operated for it.

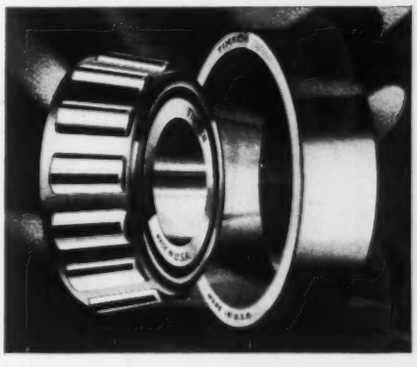
In the next cycle of the operation the hood, which includes a spring-pressed sealing plate, and the strainer are raised. Subsequently the wheel *A* is turned to remove the filled mold and place an empty mold beneath the strainer. As



LeBlond No. 6AC Double Spindle Crank Shaft Lathe equipped with Timken Bearings on all spindles and at other important points.

PROLIFIC PERFORMANCE

Many of the most wonderful machines in the world are engaged in the production of automobile parts.
Timken Bearings have kept pace with all of these developments, meeting every demand for anti-friction efficiency, accuracy and endurance with consistent dependability.



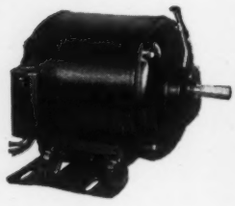
Timkens' versatility in fully meeting every bearing requirement in every type of equipment comes from the exclusive combination of Timken tapered construction, Timken positively aligned rolls and Timken Alloy Steel . . . a combination that assures the safe carrying of all loads —radial, thrust and both together in any combination; the precise performance of spindles; and the holding of shafts, gears and other important moving parts in correct and constant alignment.

Machine designers and machine operators know that it pays to specify Timken Bearings.

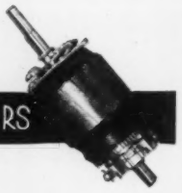
THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *TAPERED ROLLER* BEARINGS

HERE'S WHY WAGNER MOTORS ARE QUIET

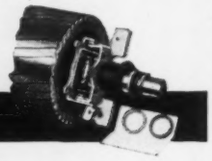


1 ● **Rotor** is dynamically balanced to eliminate vibration and noise arising therefrom. The number and the dimensions of rotor slots are carefully chosen to minimize magnetic noise.



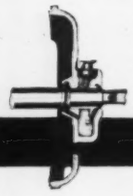
DYNAMICALLY BALANCED ROTORS

2 ● **Cork Thrust Washers** located at both ends of the motor cushion the free-end movement of the rotor thereby preventing noise.



CORK THRUST WASHERS

3 ● **Steel-backed Babbitt-lined Bearings** are diamond-bored to secure bearing clearances small enough to avoid any possibility of excessive play and at the same time have ample clearance to afford a liberal oil film between shaft and bearing.



DIAMOND-BORED BEARINGS

4 ● **Resilient Mounting,** interposed between motor frame and base, is made up of layers of rubber and steel vulcanized together — is elastic enough to absorb the small amount of vibration remaining in the most carefully-designed motor.

RESILIENT MOUNTING

There are many other features of Wagner small motors, contributing not only toward quiet operation, but toward such essentials as dependability, performance, simplicity, and appearance. These features are fully described in Wagner Small Motor Bulletin 177, which will be sent upon request.

Wagner Electric Corporation MS336-2L

6400 Plymouth Avenue Saint Louis, U.S.A.

Motors Transformers Fans Brakes

each mold reaches the bosh tank it stops above an elevator and as a latch releases cap *F* the hot billet drops down upon an elevator, to be carried away by an inclined conveyor.

The patent, designated No. 2,030,482, is assigned to Scovill Mfg. Co., Waterbury, Conn.

BY THE use of a sliding collar and a coil spring, brake lining wear is taken up automatically in a recently patented external contracting brake, *Fig.* 3. This device, assigned to Chandler & Price Co., Cleveland, is designed particularly for paper cutting machines. When it is desired to release the clutch and energize the brake, shaft *A* is rotated to move the clutch cone to the right. This brings cam *C* to bear against roller *D*, thus moving the bellcrank lever to the position shown and causing its arm *E* to push against collar *F* which in turns bear against spring *G* which forces stem *H* of the brake band downward to tighten the band about the drum.

When it is desired to engage the clutch and release the brake, shaft *A* is rotated in the opposite direction, thereby turning cam *C* in a clockwise direction and permitting coil spring *J* to rotate the bellcrank lever to the position indicated in the dotted lines. In moving to this position arm *E* forces collar *K* against shoulder *L*, causing the end of the brake band to move upwardly to relieve the braking pressure of the band on the drum. As the brake lining wears, spring *G* takes up the lost motion and thus compensates for it.

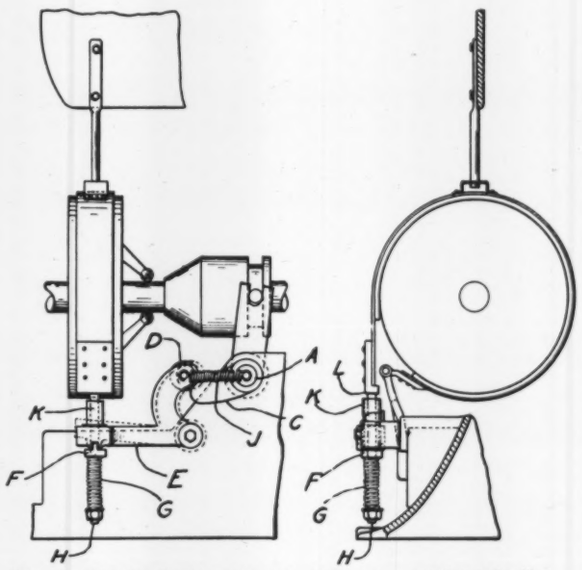


Fig. 3—Brake lining wear is taken up automatically, thus obviating any manual adjustment

Ralph S. Tyler and William M. Reichart are the inventors of the mechanism which is identified by patent No. 2,026,715.

As a design engineer, keen for ideas to increase the utility and sales of your products, weigh the value of built-in counting devices. *They are boosting sales for many other products.*

Take a few examples. Textile manufacturers use Veeder-Root Counters to record the output of their looms and as an efficient method of paying workers. Elevator manufacturers use Veeder-Root Counters to clock the miles their cars go up and down and the number of stops and starts they make.

Other manufacturers build Veeder-Root Counters into typewriters, to record production . . . into vending machines to count the coins . . . into photographing machines to eliminate fraud . . . into night deposit boxes, to detect tampering . . . into tractors and trucks for *accurate* mileage records . . . and even into machine guns, to tell gunners how many bullets are left after each burst of fire.

Many of the most profitable counter applications have been made on products that seemed to need no counters at all. The application was obvious *only after it was made.* Tell us if any part of *your* product might be improved with a built-in counting device. We work from ideas . . . and offer you the experience and facilities of the world's largest counter-building organization. *Write*—in strictest confidence.

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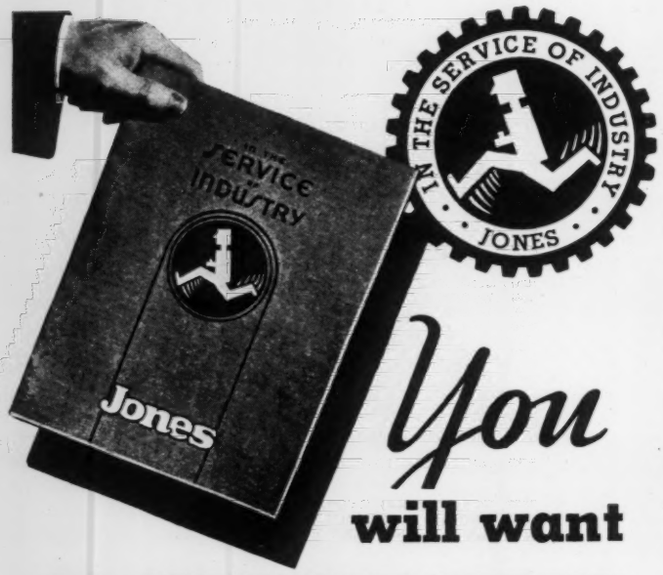
VEEDER-ROOT INC.

COUNTERS FOR EVERY PURPOSE

2264



You will want this NEW BULLETIN!

OVER ten thousand copies of this interesting new Jones bulletin have already been sent out to organizations in all fields. If you have any possible interest in drive problems such as speed reducers, cut and molded gears, V-belt sheaves, anti-friction pillow blocks, etc., you will also want to see a copy. It will give you a condensed picture of the various types of drives, how they are built, and where and how they are used. The Jones organization will be pleased to send you a copy.

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ANTI-FRICTION PILLOW BLOCKS—PULLEYS
FRICTION CLUTCHES AND TRANSMISSION APPLIANCES

Professional Viewpoints

(*Continued from page* 79)

acquainted with this subject as Mr. Karelitz, knowing full well his position as an eminent authority on bearing performance. I have read and appreciated many of his valuable contributions, and I certainly feel honored by his comments on my contribution. The purpose of the chart was graphic rather than to disclose new data.

—FRANK SCHUBERT,
Loose-Wiles Biscuit Co.

To the Editor:

REGARDING the chart on "Designing Sleeve Bearings," by Frank Schubert on page 46 of your January issue, I would like to commend the author on his work. It should be noted that he qualifies his chart and explanation by saying, "The designer therefore realizes that his final figures can only be as accurate as his practical knowledge guides his choice of calculation."

I would like to discuss this chart on the basis of data obtained from bearing test work done on special machines in our laboratory and since proved in manufacturing plants.

There is a difference in coefficient of friction dry between the different bronze alloys. For example, seventeen alloys listed in the order of their shock resistance (Sn:Cu ratio) would be in almost the same order for bearing characteristics on dry tests. The alloy with the highest shock resistance would score instantly, bearing qualities dry being zero (high coefficient of friction), while the alloy with the lowest shock resistance will heat to a cherry red (approximately 500 degrees Fahr.) and not score (a low coefficient of friction). However, when properly lubricated and tested on the machine no appreciable difference in coefficient of friction is noted. This is also true with the babbitts, but load carrying capacity of the babbitts is limited by velocity due to generated heat which softens or causes the babbitt to become plastic.

Temperature (unless influenced by outside conditions or zero lubrication) is a product of velocity and unless a correctly designed bearing is overloaded, improperly lubricated or poorly finished in the bore or shaft with improper running clearance, temperature does not materially affect the load carrying capacity. Here let me say that there is a reduction in bearing bore under elevated temperature or operating temperature that must be taken into consideration when setting running clearances and tolerances.

I would say that from our findings we can disregard coefficient of friction as we either have a well lubricated bearing or we do not, and in determining the alloy to be used we always specify the alloy that has the greatest amount of bearing characteristics that will re-

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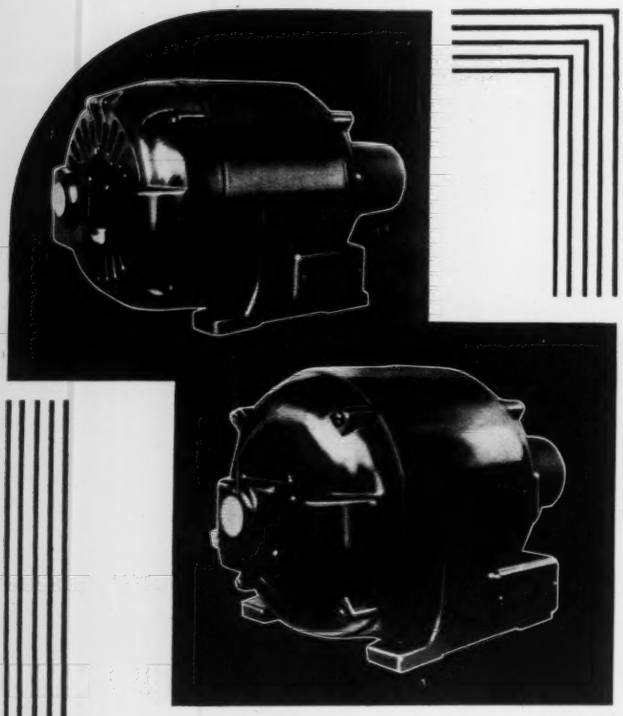


Have you noticed the trend toward

PEERLESS?

Manufacturers of air compressors, pumps and, in fact, all kinds of motor driven machinery realize the value of a motor that will stand plenty of abuse, start on low voltage, carry heavy overloads and at the same time look like "A million dollars."

That is one of the many reasons manufacturers are turning toward Peerless. Let us give you other reasons. Write for further details, Catalog 105 A.

The Peerless ELECTRIC QUALITY COMPANY
WARREN, OHIO

sist deformation with the wall thickness specified. If we cannot use the correct metal, we suggest a reduction in wall thickness or the reverse.

—R. G. N. EVANS,
Bunting Brass & Bronze Co.

Do Engineers Lack Proper Training?

To the Editor:

I HAVE read with keen interest the discussions in the last few issues of MACHINE DESIGN on the subject of engineers and their "proper" training. The last paragraph of Professor Ault's letter would contain the solution to the problem if a problem existed. My own opinion is that there is no problem other than that a business executive must train his engineers as he does any other employe.

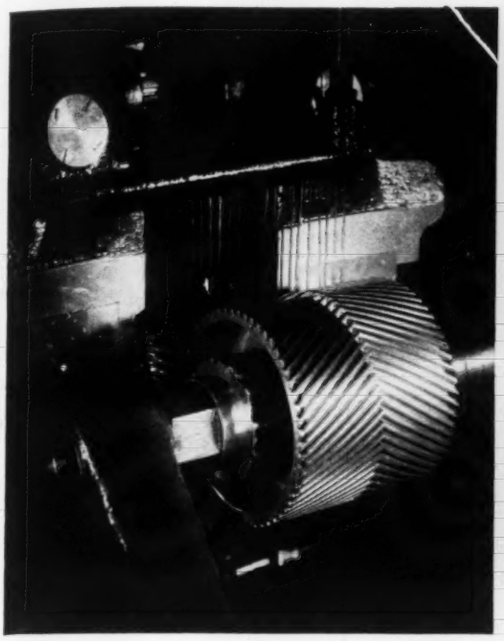
Few engineers use more than 15 per cent of the knowledge gained in their engineering courses, and it is not rational to expect that decreasing the percentage is improvement. It is difficult to understand how a college curriculum including patent law would help a maintenance engineer in a power plant. It is equally difficult to understand how advertising would help a plant production engineer or how banking would help a designer, or public speaking help a research engineer.

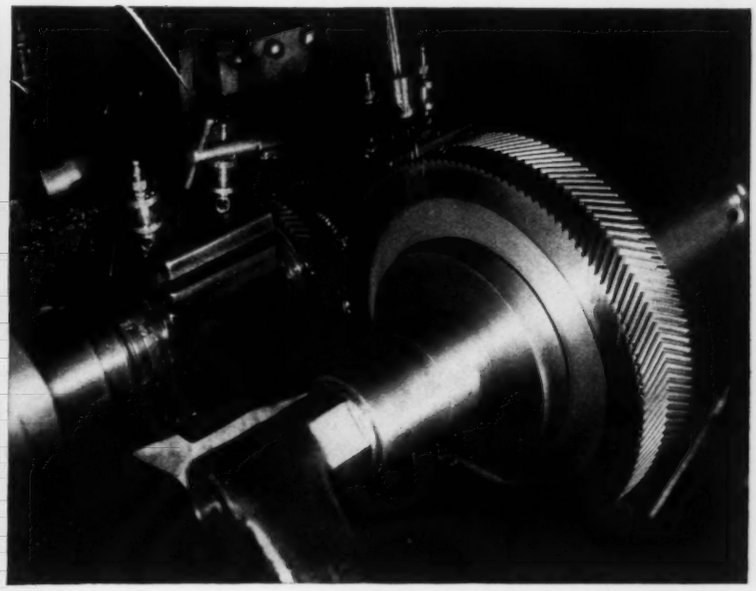
I do not, of course, speak of those department heads or engineering chiefs whose positions are fundamentally executive. Those positions necessarily require a broader base for which a graduate is unfitted.

The approach to making an engineering graduate more useful immediately upon graduation might be found in cutting down on engineering courses if such courses could be cut. The sooner a man gets out into industry, the quicker he can appraise the conditions under which he must work and prepare himself accordingly. In that respect night engineering students have a tremendous advantage over their day school brothers, which few employers realize.

Finally, two important thoughts impress themselves which cannot be lightly dismissed. First, an engineering college should no more be expected to turn out a good engineer with all the other qualifications critics demand, than should a university be expected to turn out an A. B. with the ability to visualize all the forces existing in a machine. Second, an engineering college does give the most valuable ability a man can possess, which is the ability to study by himself. It follows from this, that if particular men have shortcomings it is because they have not seen the problem of their own environment clearly, or have been unwilling to extend their own further quest for knowledge and self-improvement.

—F. H. ALEXANDER,
Woodhaven, L. I., N. Y.

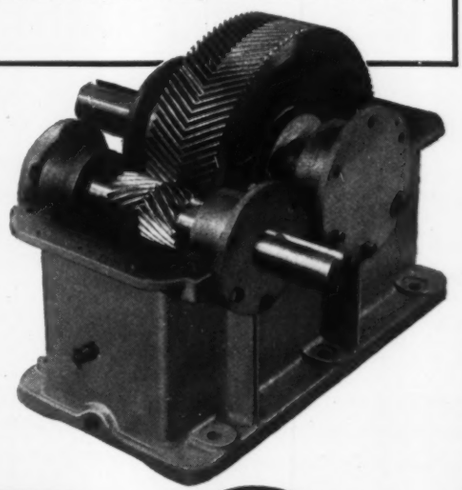




SYKES CONTINUOUS-TOOTH HERRINGBONE GEAR GENERATORS IN OPERATION

GEARS GO AROUND AND AROUND

DURABILITY, an inbuilt quality in all types of James speed reducing units, is fully developed in James generated continuous-tooth herringbone types, every effort being made to maintain our reputation as originators and builders of highly-efficient, speed-reducing equipment to suit every condition of drive.



The James continuous-tooth herringbone gears permit a greater number of teeth in contact at one time which produces a continuous, noiseless action and will withstand the maximum of load and shocks. Our large battery of Sykes generators enables us to offer you the utmost in continuous-tooth herringbone gears.

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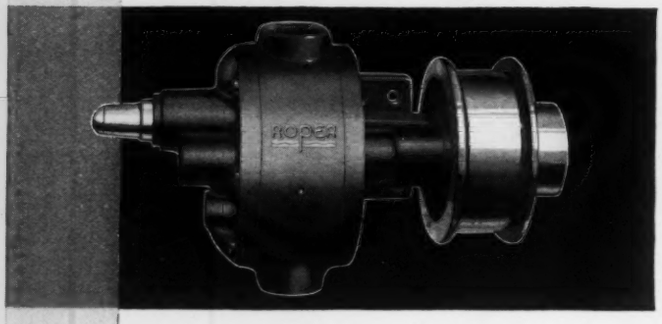


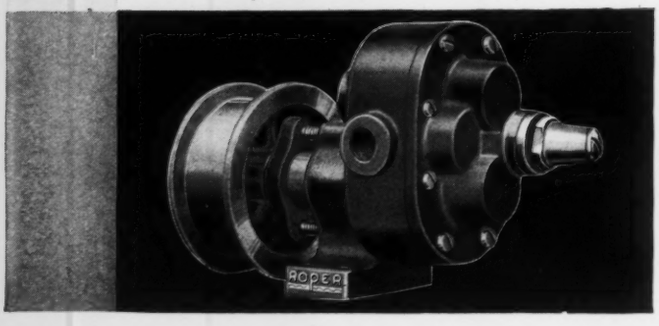
IT'S a long stretch . . . 78 years . . . long enough for any outfit to learn its business . . . long enough to prove the worth of its products.

Roper Pumps have been manufactured, sold, and used continuously since 1857. They had to be properly engineered and quality built, because no manufacturer is smart enough to fool consumers for 78 years.

The two pumps illustrated are widely used for cooling and lubricating machine tools. Your inquiry will receive special attention. Ask for Bulletin R4MD.

Geo. D. Roper Corp.,
Rockford, Ill., U. S. A.

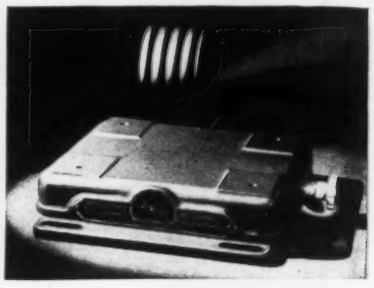
ROPER
TRADE REG. U.S. PAT. OFF. MARK REG. IN CANADA
PUMPS
Dependable Since 1857



NEW Materials and Parts

Introduces Adjustable Motor Base

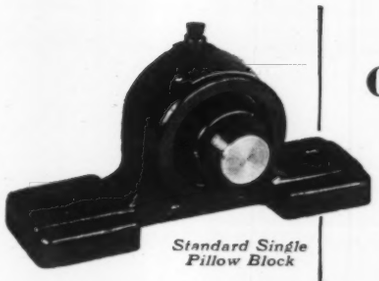
UNIFORM belt tension throughout the speed range adjustment is provided by the new Straitline automatic motor base introduced by Allis-Chalmers Mfg. Co., Milwaukee, for use with the Vari-Pitch Texrope sheave introduced recently. (M. D. Sept., p.90) This base, shown herewith, provides a convenient place from which to operate the sheave. Four ball bearings, totally enclosed and lubricated for the life of the unit, support the motor and the upper half of the motor base, enabling easy operation with little or no sliding friction. Travel of the base is in a straight line and the unit is securely anchored to the foundation. Guesswork is eliminated by a dial indicator which permits the maintenance of correct belt tension at all times. The handwheel on the base controls the speed of the variable pitch sheave and simultaneously moves the motor a sufficient amount to compensate for the change in centers between shafts resulting from the variation in the diameter of the sheave.



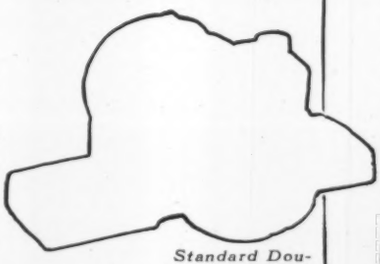
Automatic motor base is designed for use with adjustable sheaves for providing infinitely variable speeds

Mercury Switch Is Compact

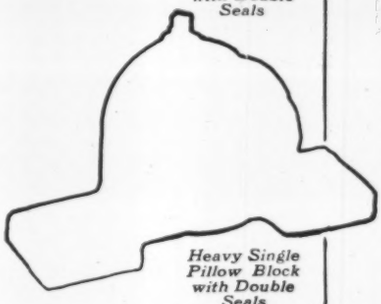
A SMALL, compact electric switch which is completely silent in operation and which has no moving parts to wear out has been introduced by General Electric Co., Schenectady, N. Y. About the size of a marble, the "works" of the new switch, shown herewith, utilize the mercury-break principle to function without a click. The switch consists of two shallow chrome-steel cups about three-quarters inch diameter, sealed together with a strip of lead glass to form a hollow compartment. Separating the cups is a disk of ceramic material in which is a small hole located near the edge. The compartment is evacuated after fabrication and about four grams of mercury are inserted, filling roughly one-quarter of the space. After inser-



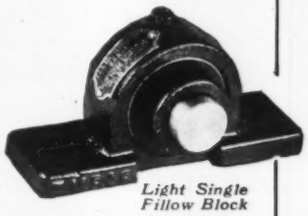
Standard Single Pillow Block



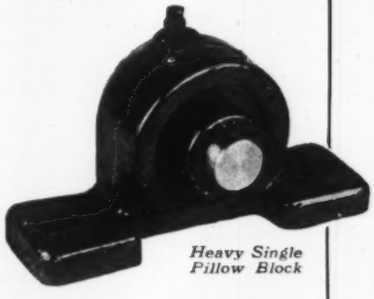
Standard Double Pillow Block with Double Seals



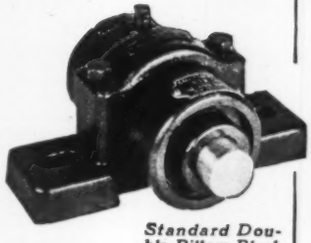
Heavy Single Pillow Block with Double Seals



Light Single Pillow Block



Heavy Single Pillow Block



Standard Double Pillow Block

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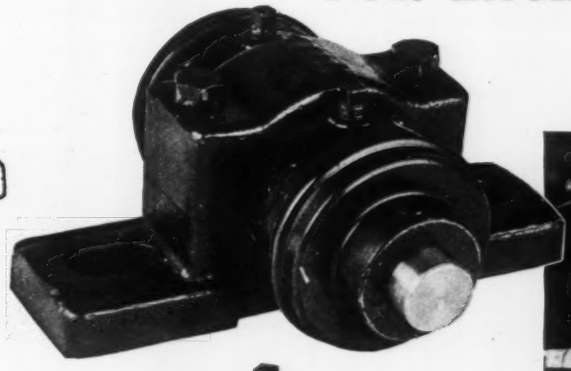
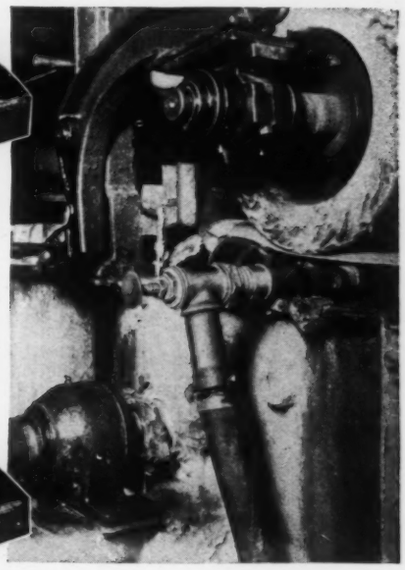
WITH THE RIGHT FAFNIR

FOR EACH SERVICE





More than 40 Fafnir Ball Bearings are in use at the Holyoke plant of the American Writing Paper Co. The couch roll application shown here is merely typical of the many places where American Writing Paper has found that the right Fafnir can, almost more than any one other factor, save power costs and make for economical operation.

Fafnir Single and Double Row Pillow Blocks, Radial and Thrust Ball Bearings, Wide Inner Ring Bearings and other types all find service in this modern paper factory. Because bearings in paper mills take unusual punishment not only from ordinary moisture in the air but also from direct hose streams . . . and grit and dirt as well . . . Fafnir Double Sealed Pillow Blocks are depended on to make possible the "uninterrupted, trouble-free operation" required of machinery that makes high quality papers.

Only because Fafnir has a bearing for every industrial need, is such specialization possible. "The most complete line of ball bearings in America" makes it easy for Fafnir engineers to recommend the *one* bearing which shall be most satisfactory for its designated application. Ask any Fafnir representative for complete details. . . . THE FAFNIR BEARING COMPANY, *New Britain, Conn.* . . . Atlanta . . . Chicago . . . Cleveland . . . Dallas . . . Detroit . . . Kansas City, Missouri . . . Milwaukee . . . Minneapolis . . . New York . . . Philadelphia.

WORTHWHILE *economies in design and production are given in every issue of Fafnir's house organ,* "THE DRAGON". *We will gladly add your name to the mailing list.*

FAFNIR
BALL BEARINGS

SHAKEPROOF LOCK WASHERS

NO OTHER LOCK WASHER
can give you this Tapered Twisted Tooth!

WHEN you buy lock washers, you want the utmost in vibration protection. Shakeproof, with its exclusive twisted tooth design, gives you a tighter, more rugged lock because each tooth forms a solid, positive contact between both nut and work surfaces. Further, because Shakeproof Teeth are tapered, an even, constant contact is maintained along the full length of each biting edge. Being made of special, scientifically hardened steel, Shakeproof Lock Washers exert a powerful spring tension that absolutely eliminates any possible backward movement of the nut. In fact, vibration cannot loosen a Shakeproof lock—it only forces the teeth in deeper and makes the lock tighter than ever. Give Shakeproof a trial in your own shop. Write for free testing samples today.

SHAKEPROOF LOCK WASHER COMPANY
Distributors of Shakeproof Products Manufactured by Illinois Tool Works
2551 N. Keeler Avenue Chicago, Illinois

tion of the mercury, the compartment is filled with hydrogen at about atmospheric pressure and sealed off by welding.

In the "off" position, the hole in the ceramic insulating disk is above the line of the enclosed mercury. However, when rotated twenty degrees the switch assumes a position where the mercury can flow through the hole, thus establishing a contact between the two chrome-steel cups and closing the circuit.

Two shallow chrome-steel cups, sealed together with a strip of lead glass, are the heart of this compact switch

Improves Variable Speed Transmission

REDESIGNED input and output units eliminate thirteen parts from the fluid power variable speed transmission of Oilgear Co., 1319 West Bruce street, Milwaukee, resulting in a considerably simplified and improved unit. This development permits increased capacities with sharp reduction in size. The friction and resistance load on each piston is lessened and the intrinsic durability of this type of transmission is increased.

In the unit, shown herewith, output speed ranges steplessly from 5 to 1090 RPM. The new transmissions are available in sizes from 2 to 100 horsepower, are controllable either by hand or by automatic direct and remote devices, and may be adapted to meet all normal and many unusual and intricate transmission needs.

Single pieces of steel are employed as cylinders in hydraulic variable speed drive

These improved transmissions are of the radial multiple piston type. In the new design a single piece of steel, exactly machined in the form of a rolling piston, replaces the fourteen parts formerly required to accomplish the same motions. More of these new pistons can be placed

Don't Miss It!

Stapled into the center of this issue, as it leaves our offices, is the fourth edition of Machine Design's Directory of Materials Used in Design of Machinery. This covers Pages 43-1D to 78-36D inclusive.

Chief engineers and others responsible for design cannot afford to be without this directory. It includes every alloy and nonmetallic material of importance in design work.

To meet requests prior to publication and to take care of the customary demand for extra copies, reprints are being made available. These will be mailed postpaid at twenty-five cents per copy.

FIVE POINTS OF SUPERIORITY

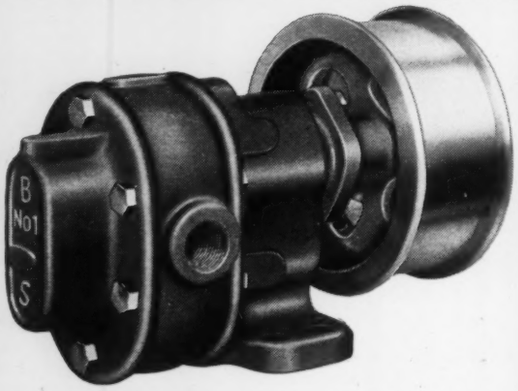
ENGINEERING SERVICE
SELECTED MATERIALS
DEPENDABILITY
DELIVERY AS WANTED
ACCURACY TO SPECIFICATION

YOU CANNOT REALIZE THEIR VALUE UNTIL YOU TRY THEM.

GIBSON SPRINGS

WM. D. GIBSON CO.
1010 WILLOW STREET
CHICAGO, ILLINOIS

1S
2S
3S



Investigate this New Outstanding Design

of Rotary Geared Pumps
with Helical Gears

. . *Higher Speeds*
. . *Quietness*
. . *Long Life* B·S

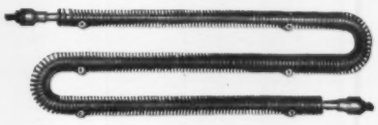
Write—Brown & Sharpe Mfg. Co., Providence, R. I.

Brown & Sharpe Pumps
Geared — Vane — Centrifugal

in the cylindrical area available and additional rows can be placed compactly in the longitudinal section of the cylinder.

Heating Units Are Finned

CALROD heating units intended principally for air heating, where the air is forced over the heating units, and for such applications as various types of unit heaters and the heating of air-conditioned railway cars on electrified lines have been announced by General Electric Co.,



Heating unit consists of a steel-sheath heating element

Schenectady, N. Y. The unit, shown herewith, consists of a steel-sheath heating element with steel fins copper-brazed to the sheath. The copper brazing process provides thermal contact between the fins and the unit sheath and delivers an increased amount of heat in a given space for a given rating.

Develops Phosphor Bronze Electrode

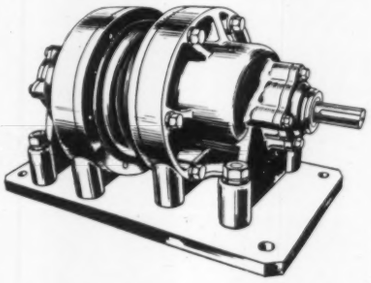
A SOLID homogeneous deposit with characteristics of true phosphor bronze having high tensile strength is provided by the new "Aerisweld" electrode of Lincoln Electric Co., Cleveland. This phosphor bronze electrode, of the shielded arc type for use with the metallic arc, can be employed in the fabrication of parts of bronze, brass or copper. Preheating of the parts is unnecessary when welding any ferrous metal and the lighter grades of copper and bronze. Busbars, large contacts, impeller blades in pumps and turbines, etc., may be welded with the equipment which also may be used for welding galvanized sheets where minimum disturbance of the galvanizing is essential.

Weights Create Vibrations

EMPLOYING a new application of the principle of double rotating weights, the mechanical vibrator of Ajax Flexible Coupling Co., Westfield, N. Y., consists essentially of two offset weights mounted on shafts and geared together so that when one shaft is rotating the other must also rotate at the same speed but in the opposite direction. The use of two weights instead of one permits directional control of the impulses of vibration. Amplitude of vibration is controlled by the amount of offset weight.

The unit shown in the accompanying illustration when running at 400 RPM delivers 8000

strokes or blows per minute, each having a force of approximately 2400 pounds. In the design, bearings, housing, size and speed requirements are engineered to suit each specific application.

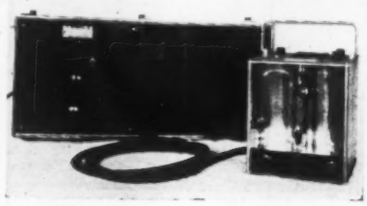


Alloy, heat-treated steels are employed in mechanical vibrator which uses double rotating weights

Alloy, heat-treated steels and antifriction bearings are employed. The housing is oiltight and dustproof. In addition to many special applications, common use is found in conveying, screening and separating.

Instrument Analyzes Motions

MOMENTARY illumination of 300,000 candlepower is produced by the new portable Stroboglow of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The instrument, shown herewith, is suited to the analysis of any periodic movement from 100 to 30,000 cycles per minute. With a maximum flashing speed of



Stroboscopic instrument shown is suited to the analysis of any periodic movement

5000 per minute, it is possible to analyze motions up to 30,000 per minute by flashing once every two revolutions for 10,000; once every three revolutions for 15,000, etc. The fields of application include the analysis of rotating and reciprocating apparatus especially in connection with vibration problems and the sequence analysis of mechanisms which have motions of a recurrent nature such as sewing machines, moving picture cameras, machine guns, etc.

Extends Line of Reset Relays

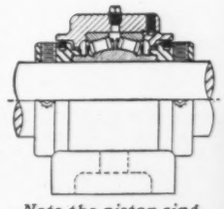
MECHANICAL latch, electrical reset relays manufactured by Struthers Dunn Inc., 139 North Juniper street, Philadelphia, have been extended to include three and four pole sizes,

BUILT TO DELIVER MORE

● Only the Shafer CONCAVE roller design combines—in a single compact bearing unit—1. Radial-thrust roller bearing capacity, 2. Integral self-alignment, 3. Simple adjustability. These features enable the Shafer bearing to meet—and conquer—even the most difficult operating conditions.

The double row Shafer roller bearing in this compact and sturdy pillow block provides generous capacity for radial-thrust loads in any combination. Its natural free-rolling self-alignment compensates for shaft deflection, shock loads, and inaccuracies of mounting. Long life and sustained efficiency are assured.

Available in full range of sizes: Pillow Block • Hanger Box • Flange Unit • Duplex Unit • Cartridge Unit • Take-up Unit • Conveyor Rolls • Radial-thrust Roller Bearings. Write for Catalog 12.

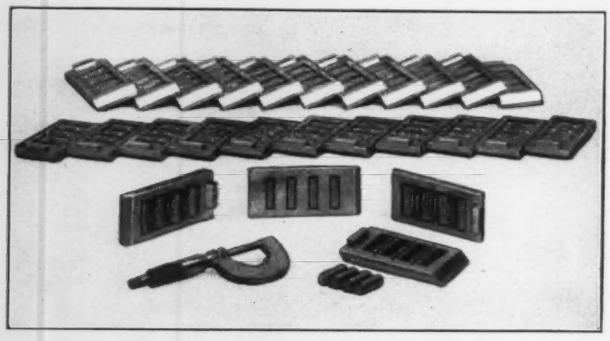


Note the piston ring seals and double end square □ drive collars

SHAFER BEARING CORPORATION
6513 West Grand Avenue - Chicago, Illinois

SHAFER
roller bearing
PILLOW BLOCKS

BANTAM
ROLLERS ROLL



Bantam supplied these unusual Roller Thrust assemblies to a well known special machinery manufacturer for use with reciprocating ram mechanisms. Cages are made of Bantam Bearing Bronze cast in one piece. Rollers are made of S.A.E. 52100 high carbon chromium electric furnace steel precision ground to a tolerance of .0001″ on diameter.

TAKE YOUR TOUGHEST BEARING JOB TO BANTAM

THE BANTAM BALL BEARING CO.
SOUTH BEND, INDIANA

Trade Mark Reg.

Chicago Youngstown Detroit New York Indianapolis
New Orleans Philadelphia Pittsburgh Rochester, N. Y.
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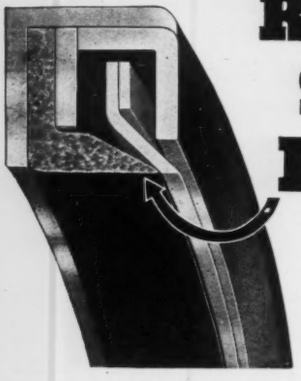
BBB ONE OR A HUNDRED MILLION 1/32″ TO 60″



Reduces Shaft Friction

The tapered edge of the leather washer of the Gits Precision Oil Seal reduces shaft friction. Only the slightest pressure at this point forms an effective oil seal.

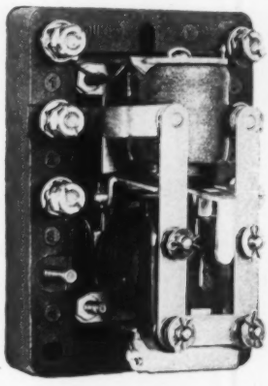
Precision Oil Seals are just that . . . they are accurately machined to very close tolerances. They are equally efficient on horizontal or vertical shafts.

A folder will be mailed at your request.

GITS BROS. MFG. CO.
1861 So. Kilbourn Ave., Chicago, Ill.

GITS Precision Oil Seal

both single and double throw. These relays are provided with two coils, one for closing and one for opening. Energizing the closing coil picks up the armature which is then latched closed by a metal latch which engages a Bakelite keeper on the armature. This combination



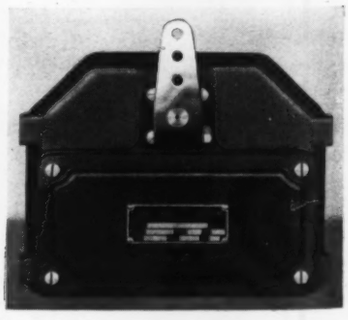
Energizing the closing coil on new relays picks up the armature which is then latched closed

eliminates sticking and reduces wear. Energizing the release coil trips the latch and allows the armature to drop out.

These relays may be operated by momentary contact pushbuttons (or other switches) or provided with auxiliary contacts to break the coil circuits after operation, leaving the coils on the line for only a fraction of a second instead of continuously. In circuits where it is desirable to close one control contact to energize the load circuit and another one to de-energize it, such as a three-wire thermostatic control, these relays are especially adaptable.

Units Regulate Temperatures

TWO new types of multiposition controllers, known as the Relatrol and the Balancer, have been developed by Automatic Temperature Control Co. Inc., Philadelphia, for furnace tem-



Extra responsiveness in temperature controllers is provided by a special relay wired into the circuit

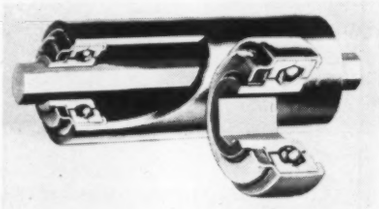
perature control with minimum disturbance to furnace atmosphere. Both units produce a corrective movement in a valve or damper in exact relation to departure from the temperature setting as measured by the actuating instrument. A special relay is supplied, wired into the circuit

between the actuating instrument and the motor mechanism. This relay embodies an electrically controlled nullpoint, and as full line voltage is used in both relay and power motor, extra responsiveness is secured to repositioning demand.

The new Relatrol action employed by these mechanisms can be used in conjunction with many standard pyrometers, flow meters and other measuring instruments by slightly modifying the contact mechanism. The Balancer is similar to the Relatrol except that it is provided with automatic means of load compensation and is recommended where load changes will be of considerable extent and duration.

Conveyor Rollers Are Improved

AN ADDITION to its "knurled-keylock" line of roller conveyors in the form of rollers incorporating hexagon shaped axles has been brought out by Mathews Conveyor Co., Ellwood City, Pa. The new line will appear similar to



Incorporating hexagon shaped axles, these rollers may be accurately locked in position

the accompanying illustration. Seamless steel tubing, hardened steel bearing parts, solid steel inner and outer races predominate. Ball bearing rollers in lengths to suit are available in a number of diameters with capacities ranging from 50 pounds continuous load rating for the 1-inch diameter to 8000 pounds for the 7⅝-inch diameter roller. Additions added to the hexagon axle line which are not available in the previous series are: A tapered steel roller 2½ to 1⅝-inch diameter, capacity 150 pounds; a 2½-inch diameter roller for heavy service, capacity 300 pounds; a 3⅜-inch diameter roller of 750 pounds capacity; and a 4½-inch diameter roller with 4000 pounds capacity.

Develops Improved Thermometers

SOCKET dial thermometers in both the self-contained type and the distant reading type are a recent development of Jas. P. Marsh Corp., 2073 Southport avenue, Chicago. The type 61 self-contained instrument fitted with a universal socket permits the use of the one instrument as a vertical connection thermometer, a 90-degree back angle thermometer, a front angle thermometer, or any intermediate angle. It eliminates

REDESIGNING FOR *Standardization*

Anticipating the trend toward standardization, Twin Disc engineers have, during the past year, redesigned the line of Twin Disc Clutches and Power Take-Offs.

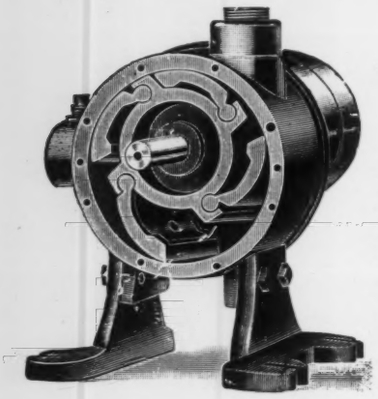
New sizes and types have been developed to meet the greater needs and specific requirements of the designer, manufacturer and user of industrial machinery. S.A.E. standards have been strictly maintained. Precision methods in manufacturing and inspection insure strict interchangeability of all parts.

The latest development—the Twin Disc Marine Reverse and Reduction Gear Unit, which, when applied to any standard gasoline or Diesel engine adapts it for marine service—was the sensation of the New York Boat Show.

Write for specific recommendations on your clutch problems. Engineering data on request. ***Twin Disc Clutch Company, 1324 Racine Street, Racine, Wis.***

TWIN DISC CLUTCHES

QUIET, POWERFUL and EFFICIENT
LEIMAN BROS. PATENT ROTARY POSITIVE
AIR PUMPS
USED BY THE WORLD'S LEADERS AS STANDARD EQUIPMENT ON ALL SORTS OF AUTOMATIC MACHINES AND DEVICES
MANY SIZES and STYLES



TAKE UP THEIR OWN WEAR
No packing or tips on the wings

The built-in one-year-lubrication of Leiman Bros. Rotary Positive Air Pumps is the new wool yarn packed bearing which holds in suspension enough lubricating oil for one year's service — strained and purified.

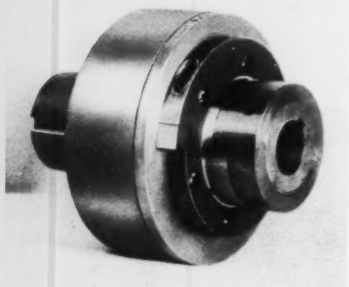
The continuous unbroken cylinder surface makes these always noiseless air and gas pumps doubly quiet. The air enters and emerges in a sidewise course through the bypass in the cylinder head side.

This means a smooth, glassy-like cylinder surface, easy operation and saving in power.

The advantage gained by this simple construction is that the wings in constant operation will wear in conformity with the inner cylinder wall and become smooth and glassy like as well as case hardened in use, and maintain a perfect fit and positive air pressure, even after long continued usage.

LEIMAN BROS., INC.
177 (3) Christie St., Newark, N. J.
LEIMAN BROS., N. Y. Corp., 23 (P3) Walker St., New York City
Makers of good machinery for over 45 years

for intermittent drives . . . .



HILLIARD SINGLE REVOLUTION CLUTCH

THIS intermittent drive clutch will engage or release on each or any number of revolutions. It operates with precision—no slip—a means to perfect timing.

For cutting stock to extremely accurate lengths, the HILLIARD SINGLE REVOLUTION CLUTCH will improve the product of your machine whether it processes paper or steel. Clutch control may be made by an automatic stop actuated by the machine itself.

Available in capacities from ⅓ to 220 H.P. @ 100 R.P.M., this clutch is ideal in both design and range for application to most modern equipment.

Write for Bulletin 102-D.

Permit our specializing experience of thirty years to select the best clutch adaptable to your needs.

Clutches for Every Purpose

THE HILLIARD CORPORATION
ELMIRA, N. Y.

the requirement of specifying a specific type of stem for each particular application.

The type 62 distant reading thermometer is standard with 6 feet of connecting tubing and a union bulb, or, in the case of high temperature thermometers, either a union bulb or a flexible plain bulb. The thermometer has a mounting

Universal socket for mounting permits the use of these thermometers in a number of different ways to suit individual applications

flange together with the universal socket which permits the installation of the instrument proper at any convenient point on top or in front of the apparatus and then to install the bulb right at the point of temperature.

Transformers Regulate Speeds

MANUALLY operated transformer speed regulators for high and low torque capacitor motors in a new line with and without full voltage starting for single phase and polyphase fan motors have been introduced by General Electric Co., Schenectady, N. Y. The units, shown herewith, consist of a tapped autotransformer

Regulators are for single phase motors rated up to two horsepower and for polyphase motors rated up to five horsepower

and a snap switch, and, for providing full voltage starting, a relay which affords automatic transfer to the desired running position. With special additions, the regulators are available for reversing service as well as for operation from external sources.

The snap switch provides for three speed positions, and other low speeds may be obtained

from the autotransformer through reconnection of the transformer types to the snap switch, giving a total of seven reduced speeds.

Constant Level Oiler Is Adjustable

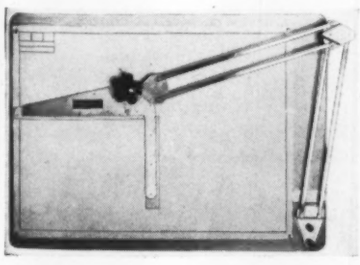
DEVELOPMENT of an adjustable type Oilit as an addition to its present line of vacuum type constant level oilers has been announced by National Industrial Products Corp., Wilkinsburg, Pa. The unit, shown herewith, is adaptable to a wide variety of equipment. It permits adjustment of the oil level in bearings at any time.

Adjustment of the oil level in bearings may be made at any time with vacuum type constant level oilers

Engineering Department Equipment

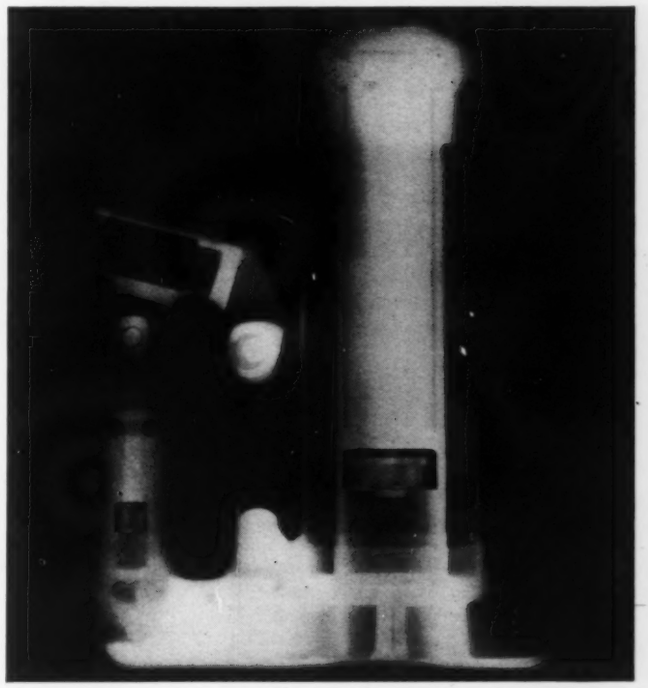
Expands Drafting Machine Line

PARALLEL mechanism of the new streamlined drafting machine of L. G. Wright Inc., 5714 Euclid avenue, Cleveland, is hand assembled with all steel nickel plated parts and solid phosphor bronze bearings. This mechanism is calibrated for accuracy. Model E-272 is mounted on a 22 by 30-inch cleated, white pine board, and is equipped with a vernier indicating protractor reading to degrees. The protractor unit has a unique chuck plate to hold the drawing attachments in alignment. The graduated L-square blade is made of Pyroxylin and riveted to an aluminum stiffener which has a satin finish to eliminate glare. Drawing edges of this blade are transparent. The machine may be obtained with a special base plate to fasten to any flat wood surface without screws or clamps.



A unique chuck plate for holding the drawing attachments in alignment is employed on new drafting machine

LET US **X-RAY** YOUR DESIGN AT THE PACKING POINT



and help you pick the proper packing

From hydraulic jacks to circuit breakers, from gasoline meters to pumps, the Packing Point is a vital point in design. Whether its a simple job or a complex one, the X-Ray thinking Graton & Knight applies to the problem, even before the first tracing is finished, will make your design job easier. Such thinking, focused with an eye trained by all sorts of difficult requirements and limitations is insurance of success at the Packing Point

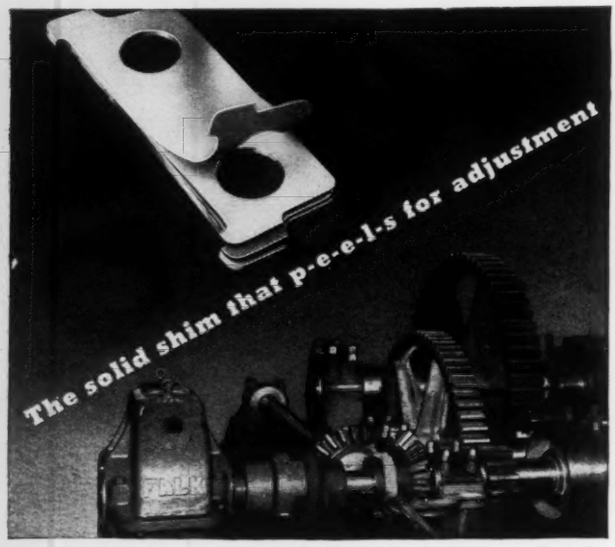
One designer knew that the equipment he had in mind would cost less, be more economical to maintain, more practical and saleable if the pressure required to make it function could be applied by a packing. After several headaches, trying to work out a suitable design himself, he turned to the Home of Research, whose Packing Engineers worked with him to create a practical assembly and packing for the job. The equipment was completed and a large industrial firm kept a step ahead of competition.

Write or wire your Packing Point Problem to Graton & Knight.

"Creating Success at the Packing Point"

"Creating Success at the Packing Point"

4201



1 of 4 Milwaukee Bridge Co. operating units at Ruby Street bascule bridge, Joliet, Ill.

● precision bearing adjustments

By adopting Laminum shims Milwaukee Bridge Co. provides quick, accurate service adjustment for the life of the equipment.

You simply p-e-e-l one or more .003" laminations at a time from the shim. No filing . . . no miking! Write for sample shim.

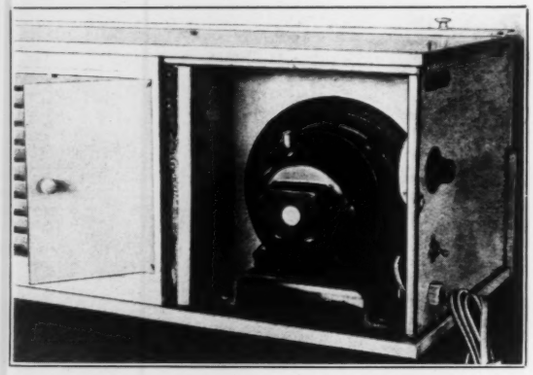
THE SOLID SHIM THAT P-E-E-L-S FOR ADJUSTMENT

LAMINUM

LAMINATED SHIM CO., INC. 2126 44th Ave., Long Island City, N.Y.

MOTORS BUILT TO FIT THE JOB

FOR AIR CONDITIONING UNITS



QUIET ● RUGGED ● DEPENDABLE

Manufacturers of motor driven apparatus and appliances have found Holtzer-Cabot Motors built to fit the job, give best results. Our engineers have a wealth of experience. Let them shoulder your motor problems.

Write us regarding your requirements—Dept. 14

HOLTZER-CABOT ELECTRIC CO.

125 AMORY ST. BOSTON, MASS.

MOTOR SPECIALISTS

Calendar of MEETINGS *and* EXPOSITIONS

March 16—

American Die Casting institute. An extensive exhibit of die castings is to open at Rockefeller Center, New York, on this date and will be on display for approximately sixty days. Applications of zinc, aluminum and brass die castings will be shown. Information may be obtained from R. L. Davis, 160 Front street, New York.

April 13-17—

American Chemical society. Semiannual convention to be held in Kansas City, Mo. Dr. Charles L. Parsons, 728 Mills building, Washington, is secretary.

April 14-18—

National Oil Burner Show. Annual exhibition of oil burners and equipment will be held at Convention Hall, Detroit. G. Harvey Porter, 30 Rockefeller Plaza, New York, is managing director.

April 20-21—

American Gear Manufacturers association. Twentieth annual convention to be held at Adelphia hotel, Philadelphia. J. C. McQuiston, Penn Lincoln hotel, Wilkinsburg, Pa., is manager-secretary.

April 20-24—

Midwest Power Engineering Conference and Midwest Engineering and Power Exposition. Conference to be held at the Palmer House and exposition at International Amphitheatre, Chicago. G. E. Pfisterer, 308 West Washington street, Chicago, is secretary.

April 20-25—

Oil Equipment and Engineering Exposition. Seventh annual exhibition of machinery and equipment is to be held at the Convention Hall, Houston, Texas. E. G. Linzner, P. O. Box 490 Houston, Texas, is general manager of the exposition.

April 22-23—

Association of Iron and Steel Electrical Engineers. Spring engineering conference to be held at Youngstown, O., under auspices of combustion engineering division. Brent Wiley, 1010 Empire building, Pittsburgh, is managing director.

May 4-9—

American Foundrymen's association. Annual meeting and exposition of equipment to be held at Convention Hall, Detroit. C. E. Hoyt, 222 West Adams street, Chicago, is secretary.

June 15-20—

American Society of Mechanical Engineers. Semiannual meeting to be held in Dallas, Texas. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary.

Future Developments in Metals Are Discussed

(*Concluded from Page* 18)

consumers all over the world will benefit increasingly by having made available to them products which meet their needs in a manner far superior to those at present obtainable."

Some idea of the potential future in metals may be obtained by the following consideration. We have at least 40 metals which may be used in making alloys. If we make all the possible combinations into binary, ternary, and quaternary systems, that is alloys of two, three, and four metals, we have the number of alloy systems shown in the accompanying table. Incidentally, we are now using many alloys that contain more than four metals. Then in order to get some figure to represent the number of possible alloys, we may assume that a variation of 10 per cent in the concentration of one element will constitute a different alloy. The resulting values are:

Possible Number of Alloy Systems and Alloys from Forty Metals

	Possible Number of Systems	Number of Alloys Variation 10%
Binary alloys	780	7,020
Ternary alloys	9,880	355,680
Quaternary alloys	91,390	7,676,760
	102,050	8,039,460

While remarkable developments have been made in metals within the recent past and more research is being done at present than ever before, the indications are that there is much to be explored and developed in the future.

SOME REFERENCES TO RELATED LITERATURE

[1] Clark, Allen F.: "Securing Corrosion Resistance at Low Cost with Clad Sheets," MACHINE DESIGN, Dec. 1934, pp. 22-24.

[2] Clark, Allen F.: "Weight, Machine Parasite, Cut With Low-Alloy Steels," MACHINE DESIGN, Dec. 1935, pp. 15-18.

[3] Cone, Edwin F.: "New Designs Demand Improved Steels," MACHINE DESIGN, Dec. 1934, pp. 31-34.

[4] DeBell, George W.: "Redesigning to Use Aluminum," *Product Engineering*, Feb. 1936, pp. 42-45.

[5] deGanahl, Carl: "Aircraft Requires Welding in Many Parts," *Metal Progress*, Feb. 1936, pp. 61-63.

[6] Faragher, Paul V.: "Alloys of Aluminum," *Product Engineering*, Feb. 1936, pp. 62-66.

[7] Frary, Francis C.: "Economics of the Aluminum Industry," *Ind. Eng. Chem.*, Feb. 1936, pp. 146-152.

[8] Gibson, A. E.: "The Development and Use of Low-Alloy High-Tensile Steels in Welded Construction," *American Journal of Welding*, Vol. 14, 1935, p. 2.

[9] Johnson, J. B., and R. R. Kennedy: "Recent Developments in Metallurgy," Aeronautic Meeting, Am. Soc. Testing Matls., Oct. 12, 1936.

[10] Kilpatrick, S. A., and O. J. Schaefer: "Stress Calculations for Thin Aluminum Alloy Sections," *Product Engineering*, Feb. 1936, pp. 49-52.

[11] Moore, H. F.: "Internal Fissures in Railroad Rails," *Metal Progress*, Nov. 1935, pp. 46-52.

[12] Newell, H. D.: "9% Chromium Steel," *Metal Progress*, Feb. 1936, pp. 51-55.

[13] Nordstroem, Gunnar: "Alloys Good at Temperatures Above 2100° F.," *Metal Progress*, Oct. 1935, pp. 68-69.

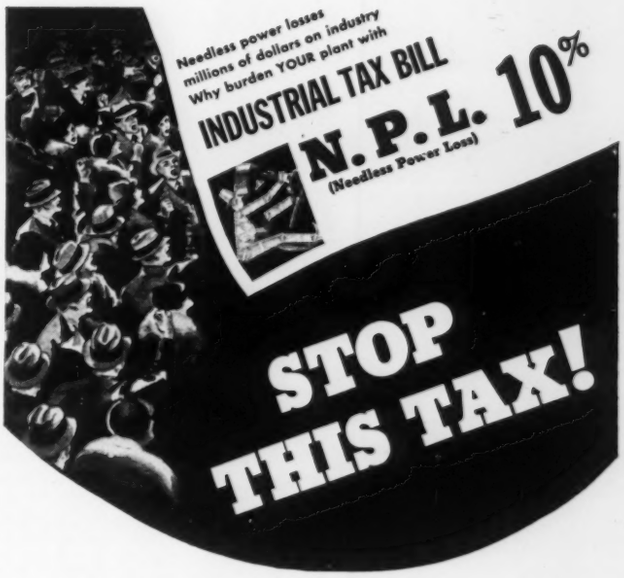
[14] Peters, F. P.: "High Temperature Alloys," *Product Engineering*, Jan. 1936, pp. 19-21. Also, "Ni-Cr Alloys for Electric Resistors," *Metal Progress*, Oct. 1935, pp. 63-67.

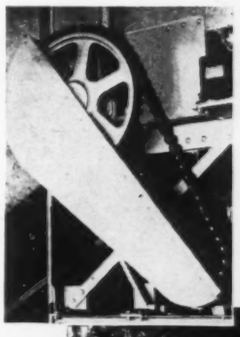
[15] Ragsdale, E. J. W.: "Stainless Steel in Aircraft Construction," Aeronautic Division, Am. Soc. Mech. Engrs., June 1932.

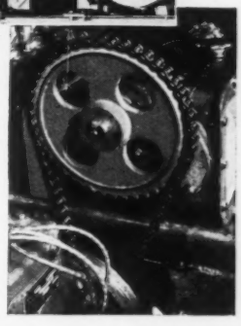
[16] Reppert, Charles M.: "Aluminum Enters Bridge Construction," *Engineering News-Record*, Nov. 23, 1933, pp. 611-615.

[17] Tuckerman, L. B.: "Aircraft: Materials and Testing," *Proceedings, Am. Soc. Testing Matls.*, Vol. 35, part II, 1935, pp. 3-46.

[18] Wilcox, R. J.: "High-Chromium Alloys—Centrifugal Castings and Tubes," *Metal Progress*, Jan. 1936, pp. 44-48.







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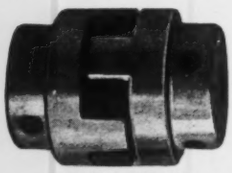

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Recent engineering tests show that the new L-R load cushion or resilient spider with its convex or flaring surface construction insures longer life and better performance by giving uniform compression. (Note drawing of this new feature at the left.) As there are no metal to metal contacts, flanges are practically indestructible. L-R Type "I-A" Flexible Couplings are available with shaft diameters from ¼" to 3". Other L-R Types up to 10" at 18 to 1500 H.P. at 100 R.P.M.

ASK FOR TEST SAMPLE. ***Give us shaft dia., h.p. and r.p.m. and we will ship an L-R Flexible Coupling for testing. Engineering data available. Write Lovejoy Tool Works, 5018 West Lake St., Chicago, Ill.***

Properties of Molded Plastics Cover Wide Range

(Continued from Page 33)

sistance; resistance to water, alcohol, dilute acids, and alkalies. It is capable of molding to close tolerance; is nonbleeding; free from odor and taste; has high heat resistance; and has excellent radio and electrical characteristics.

Plaskon

Plaskon was the first successful urea-formaldehyde synthetic. It may be molded in the same molds as the phenolic resinoids.

Exceedingly strong for its weight, Plaskon is a so-called shatterproof plastic, and takes all colors from white translucent through the pastels to jet black. Moldings of Plaskon are inert, light-fast, odorless and tasteless. They should not be subjected to water constantly, nor to temperatures exceeding 160 degrees Fahr. constantly or 245 degrees Fahr. intermittently. They are affected by strong acids and alkalies, but resist soap, borax, weak acids, oil, alcohol, acetone, and most common solvents.

The clear translucency and unique surface resistance of Plaskon suit it to uses where it is handled and washed, and where its exceptional light transmitting qualities are a factor. Thus it finds use in clock and radio cases, large housings, electric outlet plugs, illuminated panels, automobile instrument board dials, and the like. Plaskon's physical properties are given in the table.

Beetle

Beetle is a urea-formaldehyde compound which is thermosetting in the same way as the phenols, and uses the same type of dies for molding.

Radiant color is Beetle's chief appeal. The basic resin is a nearly colorless translucent, with the appearance and deep lustre of opal glass, which may be pigmented with almost any color from pastel to vivid and vibrant tones, solid white, or dead black.

Beetle is light-fast in all but the faintest shades, unless exposed to direct sun and weather; will endure boiling water for 30 minutes without deleterious effects; is noninflammable, but chars at 200 degrees Cent. making it unsuitable for articles such as ironing cord terminals.

The widest use for Beetle has been in articles having eye-appeal in clock cases, surgical and kitchenware handles and knobs, lighting and electrical fixtures, etc.

Cost of Beetle moldings is higher than that of the phenolics because of the excessive care re-

quired to keep air-borne dust and flecks out of these delicately-hued pieces, and the inevitably high percentage of rejections. Light transmission of Beetle is for natural section .044-inch, 56 per cent.

Tenite

This is a thermoplastic material made from cellulose acetate. It has greater toughness, strength and resilience than any other plastic, suiting it for thin-walled parts where a high-strength-to-weight ratio is demanded. Tenite has uniform texture, stability, unusual machinability, smooth finish, and high lustre. It ranges from a clear transparent to variegated and iridescent effect, transparent color, and solid color. Where great depth and richness of color is desired, Tenite is unsurpassed.

Tenite is not harmed by vegetable or mineral oils, but should not be subjected to heat in excess of 160 degrees Fahr. or to strong acid and alkali solutions. This plastic supports combustion with difficulty, will burn like fiber or hard wood.

Having no taste or odor, and providing a pleasant sensation to the touch, due to its peculiarly velvety surface and low heat conductivity, Tenite is especially well adapted to articles that come in contact with the skin.

These qualities have led to its use for: Adding machine keys, refrigerator handles, film cores, commutator parts, vibrator parts, hearing aid devices, fishing reels, light switches and illuminated panels.

Injection Process Broadens Field

Injection molding is the newest of thermoplastic molding processes, bringing new design possibilities and new high production economies to molding. The injection process resembles the conventional metal die casting process in many respects; a heated mass of plastic is forced automatically into a watercooled mold, filling the mold and setting on the instant.

By injection, multiple molding of small articles is possible. Thin-walled articles impossible to mold in the usual processes are feasible because the force exerted behind the plastic fills the mold completely. Zinc, brass or other metal cores or inserts costing less than an equal mass of plastic may be covered with plastic, giving the finish and appearance of a solid plastic casting at reduced cost—an impossibility in conventional plastic molding.

Mold costs, too, are sharply reduced by injection; this process operates at such high speed that great production is attained with fewer molds.

Injection molding secures all these advantages for practically any casting weighing no more than an ounce.

• Confidence and long standing good-will are about the only requisites that could possibly sell, on a single order, a shipment of fifty blue-printing machines newly placed on the market. That, marks an instant acceptance of improvement in design.

The new Paragon SC Machine is a 42″ continuous printing, horizontal unit equipped with either two or three mercury vapor lamps extending across its full width. Variable and positive printing speeds are provided. Both feeding table and receiving tray have been designed for operator's ease, which, together with its general rugged construction and attractive price makes this new SC Printer ideally suited for medium sized drawing room requirements.

Prices and complete literature on this unit or on the complete Paragon-Revolute line of blue printing equipment will be mailed promptly without obligation.

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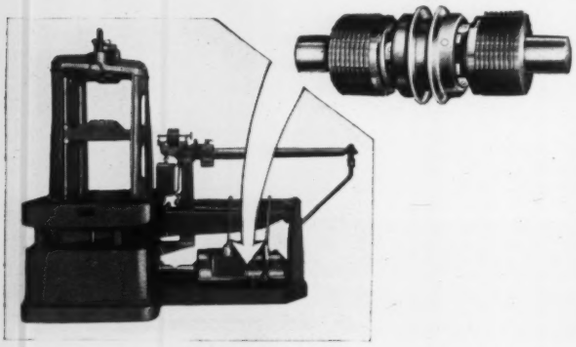

Shown above is a Riehle Testing Machine, made by American Machine & Metals Manufacturing Corporation, East Moline, Illinois. A Pullmore Double Type Clutch is used in the gear box of these machines, and its performance is "entirely satisfactory". Pullmore Clutches are used with equal satisfaction in many other kinds of machinery. Made in single and double types, for operation dry or in oil, with capacities ranging from 1 h.p. to 75 h.p. at 500 r.p.m.; Pullmore Industrial Clutches lend themselves readily to machine design, occupy very little space, are extremely reliable and durable in operation. The broad experience of our engineering department in making Pullmore Clutch applications is available, without charge, to engineers, designers, and other executives interested in reliable power transmission and control. The Pullmore catalog will be sent promptly on request—write for it today.

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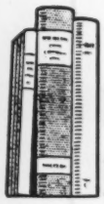

MANUFACTURERS' PUBLICATIONS

ALLOYS (STEEL)—Abrasion resisting steels, especially developed to satisfy applications where the material is subjected to severe abrasion forces, are presented in a new bulletin of Carnegie-Illinois Steel Corp., Pittsburgh. Properties of the material and methods of forming are included in the publication.

BEARINGS—Bearings Co. of America, Lancaster, Pa., has published a new ball bearing engineering data book which contains dimensions, load ratings, etc., for all sizes and types of ball bearings and has simplified tables for easy interpolation of loads at in-between speeds. There are also included complete descriptions of prelubrication and enclosure features.

BEARINGS—Engineering fundamentals involved in correlating design requirements, load characteristics and service conditions to the choice of the particular size and type of bearing are presented in a most complete and well-prepared form in a new engineering manual of Fafnir Bearing Co. Vector diagrams and load formulas for belt, chain and rope drives, gearing of several types, etc. reveal the customary forces acting on the bearing and the limiting forces which apply. Copies of the manual will be sent to executives and engineers writing on company letterhead.

CONTROLLERS—Automatic controls of many types for heating, air conditioning, refrigeration and various other industrial applications are completely presented in the new catalog 100 of Mercoid Corp., 4201 Belmont avenue, Chicago.

CONTROLLERS—Motor-operated units which position control valves or dampers with precision with the result that flow is related exactly to the demand of the moment are described in a new catalog insert of Automatic Temperature Controls Co., Philadelphia.

COUPLINGS—Chicago Rawhide Mfg. Co., 1304 Elston avenue, Chicago, is distributing a folder on its flexible coupling which is composed of three parts; the case, the spider and three tight fitting rubber cushions specially compounded to resist a limited amount of oil and high temperatures.

DESIGN DEPARTMENT—New models of drafting machine including a unit mounted on a cleated, white pine drawing board are presented in a folder of L. G. Wright Inc., 5714 Euclid avenue, Cleveland.

DRIVES—Stock roller chain sprockets of the cut-tooth type manufactured by Charles Bond Co., 617 Arch street, Philadelphia, are listed and described in a new bulletin on these parts recently issued by the company.

DRIVES—Oilgear Co., 1319 West Bruce street, Milwaukee, has published a new engineering bulletin, No. 60,000, giving complete details of its redesigned variable speed transmissions. The improved simplified designs permit

increased capacities with reduction in size. Friction and resistance load on each piston is lessened.

DRIVES—The customer's problem in the selection of worm gear speed reducers including the influence of design and the influence of proper selection is given in a recent 86-page booklet of Foote Bros. Gear & Machine Co., 5303 South Western boulevard, Chicago. Complete tables of engineering selection data, dimensional data and specifications are presented.

DRIVES—An attractively illustrated bulletin, No. 1261, recently prepared by Allis-Chalmers-Mfg. Co., Milwaukee, gives complete details on the company's new vari-pitch Textrope sheaves for variable speed drives. Both the stationary controlled type and the motion controlled type together with the new "straitline" automatic ball bearing motor base which permits complete adjustment while in operation are covered.

FELT—A concise review of applications of felt which benefit industry, and of the characteristics of this material which give it its properties so necessary to these applications is presented in a new booklet entitled "Felt Uses" published by The Felters Co. Inc., 210 South street, Boston, Mass. The booklet also includes a summary of recent test results.

PUMPS—Worthington Pump & Machinery Corp., Harrison, N. J., is distributing new bulletins on its pumps of the internal sleeve bearing, double helical rotary type, the internal roller bearing, double helical rotary type, and the external ball bearing, double helical rotary type.

SPRINGS—A workable chart for calculating the weight of helical torsion springs of round steel wire is included in the February, 1936, issue of *The Mainspring*, published by Wallace Barnes Co., Bristol, Conn. A complete explanation of the chart is included.

TUBING—Condenser tube cement known as Debecote for use in combatting the erosion of tubing is described in a bulletin of Debevoise Co., 974 Grand street, Brooklyn, N. Y.

WELDED PARTS AND EQUIPMENT—Electric welding products, electrodes, arc welding machines and miscellaneous apparatus are described and illustrated in a 32-page booklet recently issued by Air Reduction Sales Co., 60 East Forty-second street, New York.

Research Publications

The Properties of Gray Iron Castings as Effected by Superheating Temperatures, by M. F. Surls and Frederick G. Sefing. The melting and refining of gray cast iron mixtures has become a subject of increasing importance due to the present tendency toward the use of high quality castings. The subject therefore has recently been given much attention by investigators and as a result many changes in melting procedure have been suggested. In order that the influence of any one factor in melting may be studied it becomes necessary to control the melting and freezing conditions to such a degree that the factor under investigation is the only one which will vary. An attempt at such control was the aim of the authors in the study described in this report. Published as Bulletin No. 65 by Michigan Engineering Experiment Station, Lansing, Mich. 25 pp. 25c.

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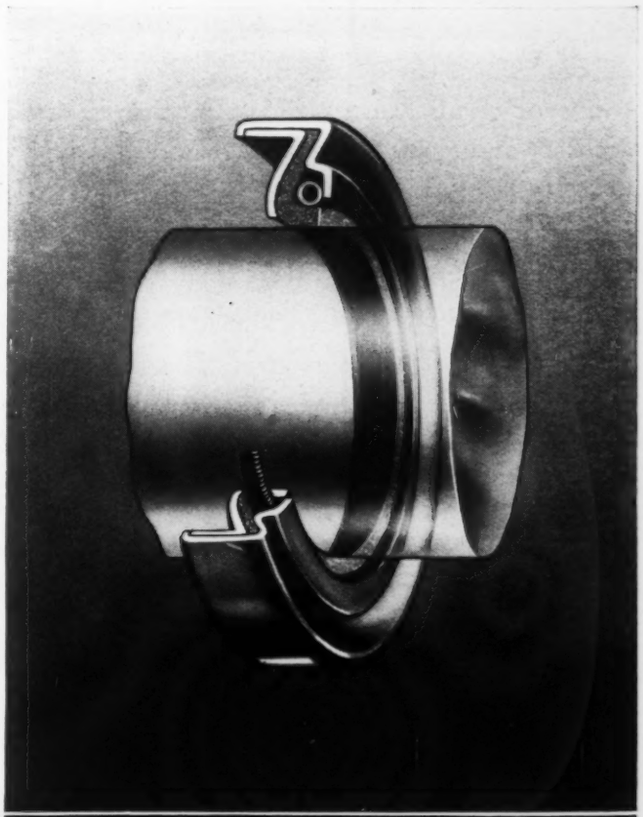

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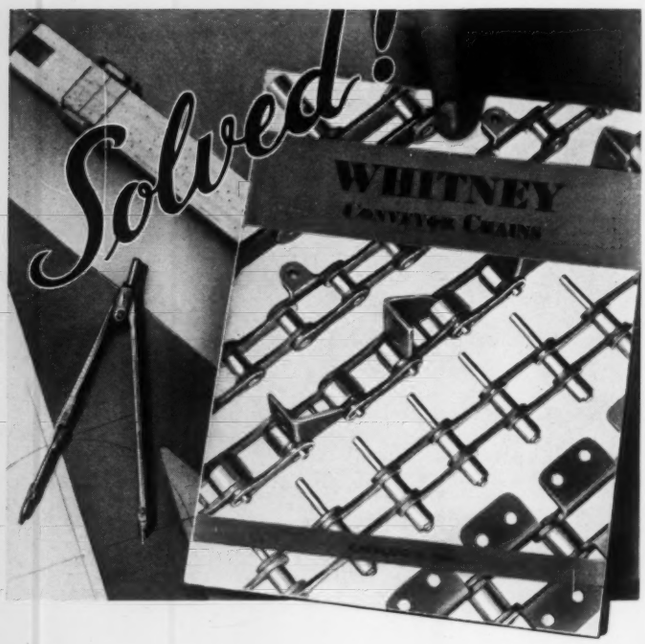

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*Advertisements appear in previous issues.

Business and Sales Briefs

S. C. PARTRIDGE has been appointed assistant general manager of the industrial division of Timken Roller Bearing Co., with headquarters in Canton, O. F. B. Yates is now manager of the New York district office of the company, in charge of industrial sales. R. W. Powers has been transferred from the Canton engineering department to the New York district sales office as sales engineer, assisting Mr. Yates. S. C. Merrill has been promoted to the position of Eastern district manager of the automotive division for the Timken company, with headquarters in Detroit.

* * *

Harnischfeger Corp., Milwaukee, has appointed Charles R. Surface as sales manager of the P&H electric motor sales division. Mr. Surface will maintain offices at the plant in Milwaukee.

* * *

Lincoln Electric Co., Cleveland, has moved its Pittsburgh office to larger quarters at 926 Manchester boulevard. F. M. Maichle is district manager.

* * *

Harold Van Doren & Associates, industrial designers, Toledo, O., has been formed to supersede the firm of Van Doren & Rideout which was recently dissolved after a three-year partnership.

* * *

George Dandrow has been appointed manager of the New York district for Johns-Manville Corp., in the power products and industrial department. Mr. Dandrow will have offices at 22 East Fortieth street, New York.

* * *

Link-Belt Co. has moved its St. Louis district office to 1018-21 Louderman building, 317 North Eleventh street. Larger quarters are thus provided to accommodate increasing business. Howard L. Purdon is district sales manager.

* * *

R. H. Sonneborn is now special sales representative of the Tubular division, Republic Steel Corp., with headquarters in the Republic building, Cleveland. Charles W. East has been appointed as district sales manager for the company with headquarters in Houston, Texas.

* * *

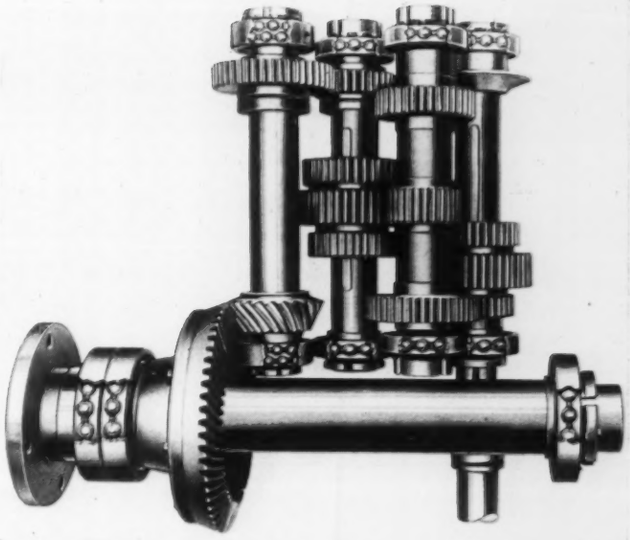
R. J. Eckstein has been appointed manager of the Cleveland office of Cutler-Hammer Inc., Milwaukee. Mr. Eckstein has been associated with the company for twenty-five years. The Cleveland office is located at 1405 East Sixth street.

* * *

C. F. Burgess Laboratories Inc., Madison, Wis. has opened a research laboratory at 115 West Willis avenue, Detroit, to render laboratory service on subjects related to elimination of motor car noises, the development of improved ventilation, and the filtration of air supplied to engines, cabs, car bodies, etc.

* * *

C. L. Huff, formerly sales manager in charge of West-



Why Should I Bother About Gears?

Gears are so common throughout industry that their importance is sometimes overlooked. That is when they cause the most trouble. It pays—and well—to bother about gears before they give trouble, rather than waiting until after it has developed.

Our business has grown on the basis of making gears to meet a need rather than a price; of working *with* manufacturers who know that it is wise policy to build the best possible gears into their product. Frequently, through sound engineering and the use of different steels and heat treating, this can be done at a real saving in costs.

The complete facilities of our engineering and metallurgical departments, our completely equipped forge and gear shops and over forty years experience in the knowledge of gears and their uses, are at the disposal of those who appreciate the necessity of the right gears in any product which bears their name.

OHIO FORGE *and* MACHINE CORP.
Successor to GEARS & FORGINGS INC.
CLEVELAND, OHIO
OHIO F&M CO